Aotearoa New Zealand Antarctic and Southern Ocean Research Directions and Priorities

2021–2030

New Zealand Government

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Through perception comes awareness
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Through understanding comes knowledge
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Foreword

Aotearoa New Zealand's environment is connected to Antarctica and the Southern Ocean. From early Polynesian voyages south, through to New Zealand's more than 60-year Antarctic and Southern Ocean research effort, and the establishment of Scott Base in 1957, New Zealanders have a deep connection to this unique and fragile place on our southern flank. It is a part of our heritage and a critical part of our future.

Ten years ago, the Government set the directions and priorities for New Zealand's research and science in Antarctica and the Southern Ocean for 2010–2020. The enduring priorities that underpin our research have not changed: we continue to prioritise the environmental protection of Antarctica and the Southern Ocean; we value healthy and productive ecosystems; and we are committed to protecting biodiversity.

But a lot has happened since 2010. Now more than ever there is a need to understand how processes in Antarctica and the Southern Ocean influence our planet's climate system and the implications of global climate change for future generations of New Zealanders and for our planet.

This document provides refreshed, contemporary priorities for New Zealand's Antarctic and Southern Ocean research under the unifying theme of global change. We intend that the priorities and directions provide guidance to both researchers and government agencies, in particular with respect to investment.

Aotearoa New Zealand's Antarctic and Southern Ocean research will have impact, be excellent, and make connections. It will advance New Zealand's Commitment to Antarctica and the Southern Ocean. It will uphold the principles of Te Tiriti o Waitangi, and recognise and reflect the value of mātauranga Māori. And it will contribute to New Zealand's climate change, Antarctic, and environmental policies.

In 2021, we celebrate the 60th Anniversary of the Antarctic Treaty coming into force. Aotearoa New Zealand was one of the 12 original signatories to the Antarctic Treaty in 1959, and we look forward to many years ahead of cooperation with international partners and world-leading Antarctic research by New Zealand scientists and researchers, to inform and support the protection of Antarctica in accordance with the principles of the Antarctic Treaty. A foundation of the best available science ensures that the Antarctic Treaty System continues to align with Aotearoa New Zealand's values and that Antarctica remains forever a place for peace, cooperation, and science.

Hon Nanaia Mahuta
Minister of Foreign Affairs

Hon Megan Woods
Minister for Research, Science and Innovation

Hon David Parker
Minister for Oceans and Fisheries

Hon Kiritapu Allan
Minister of Conservation

Hon James Shaw
Minister of Climate Change

Vision

Excellent and impactful science that addresses the urgent need to understand the role of Antarctica and the Southern Ocean in a globally-connected and rapidly changing environment and supports Aotearoa New Zealand's commitment to protecting Antarctica and the Southern Ocean.

Purpose

This document sets the high-level directions and priorities for Aotearoa New Zealand's Antarctic and Southern Ocean programme of research under the unifying theme of global change. It builds upon and progresses the previous document which set the Antarctic research directions and priorities for the period 2010 – 2020.

For New Zealand's government agencies, this document identifies Antarctic and Southern Ocean science priorities that require research, logistics and infrastructure investment over the next decade.

For researchers and communicators, this document identifies goals and government objectives for research through guiding principles and four priority research directions of:

- sea level rise
- cryosphere–ocean–atmosphere connections
- ecosystem dynamics
- protection of Antarctic and Southern Ocean environments.

This document was completed after a Cabinet-mandated public consultation process that ran from 19 July to 16 August 2021.

Unifying theme

The unifying theme for Aotearoa New Zealand Antarctic and Southern Ocean research is **global change.**

New Zealand is committed to understanding Antarctic and Southern Ocean environments, and their role in global systems. This unifying theme is intended to stimulate multidisciplinary research to quantify the processes that drive the state of natural systems to enable projections of future change and understand the implications of anticipated change.

New Zealand will lead, support, and share research that increases understanding of the interaction between global systems and Antarctica, and advances New Zealand's climate change mitigation and adaptation policies and capability to respond to change.

Guiding principles

Aligning with Government priorities, Aotearoa New Zealand's Antarctic and Southern Ocean research will:

1) Be *excellent* and have *impact*

   a) make *connections*[1] through the development of national and international partnerships and multidisciplinary collaborations

   b) promote responsible innovation, development and use of emerging technologies relevant to the research priorities in this document, to improve efficiency, safety and reduce environmental impacts

   c) foster the next generation of researchers and communicators and actively promote diversification of the research community with respect to culture, race, ethnicity, gender, generation, and expertise.

   d) produce data and samples that are managed in accordance with the Antarctic Treaty (Article III) and guided by *FAIR (Findable, Accessible, Inter-operable, Reusable)* (link) and *CARE (Collective Benefit, Authority to Control, Responsibility, Ethics)* principles (link)

2) Uphold the principles of Te Tiriti o Waitangi[2]

   a) be guided by manaakitanga[3]

   b) recognise that Māori have their own knowledge system, mātauranga Māori, which enhances science and research in Antarctica and the Southern Ocean

3) Sustain New Zealand's *Commitment to Antarctica and the Southern Ocean*

   a) advance New Zealand's climate change mitigation and adaptation policies and support New Zealand's leadership within the Antarctic Treaty System

   b) focus on the Ross Sea region, while also recognising the importance of collaborative research in other areas of Antarctica and the Southern Ocean

   c) be well-connected to end users and support evidence-based decisions

   d) be effectively communicated to New Zealanders

   e) be supported in Antarctica only if the research cannot be done elsewhere or through the use of existing data, collections or remote observations

   f) be carried out in accordance with all relevant legislation

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[1] From the National Statement of Science Investment 2015-2025:

'Excellence' takes account of factors including the skills of individuals and institutions that are brought together to address research needs, the rigour of the research process and the application and dissemination of the knowledge gained.

'Impact' encompasses the ways in which scientific research benefits individuals, whānau, communities, organisations, New Zealand, and the world. Researchers are encouraged to engage with stakeholders from the outset to identify the implications and benefits of the research, in accordance with the needs and interests outlined in this document. Demonstrating research impact will be an important component of measuring success.

'Connections' accommodates the importance of scientific cooperation both nationally and internationally and acknowledges the emphasis that the Antarctic Treaty places on international cooperation in scientific investigation in Antarctica. Collaboration, in particular international collaboration, enhances logistical efficiency, strengthen its research, skills development, knowledge exchange and influence. Developing interdisciplinary research programmes that bring together the right expertise to address research questions is an important element.

[2] In this document, Te Tiriti o Waitangi refers to all versions of The Treaty of Waitangi, including both English and Te Reo versions. Te Tiriti should prevail if the versions are not clear or at odds.

[3] In this context, manaakitanga is about enhancing the mana of all: caring for, honouring and respecting ourselves, others and the natural environment. See Statement of Commitment to Antarctica and the Southern Ocean, appended to this document and online here.

Context

The importance of Antarctica and the Southern Ocean

To understand our planet's climate system, and the implications of climate change for future generations of New Zealanders, it is crucial that we understand how processes in Antarctica and the Southern Ocean influence our planet's climate system and the implications of global climate change for Antarctic ecosystems.

Natural and anthropogenic changes influence Antarctica through oceanic and atmospheric processes, and influence the Antarctic atmosphere, ocean, ice sheets, sea ice and biosphere. In turn, changes in Antarctica and the Southern Ocean directly affect global environments through ocean and atmospheric circulation and changes in primary productivity and ecosystems.

The Southern Ocean is absorbing as much as 75% of human-induced warming and 40% of the global ocean up-take of anthropogenic carbon dioxide. The Antarctic Circumpolar Current (ACC) has a major influence on global ocean heat fluxes and biogeochemistry.

The ozone hole and atmospheric circulation patterns around Antarctica heavily influence oceanic circulation patterns, weather systems and atmospheric composition of the southern hemisphere, including over the New Zealand region.

Sea ice in the Southern Ocean is crucial in the global climate system and the life cycles of marine organisms. The annual formation of Antarctic sea ice doubles the ice-cover of the Southern Hemisphere every winter, and the growth/melt cycle exerts strong influence over large-scale processes such as the ocean heat flux and global ocean overturning circulation.

By returning nutrient-rich deep water to the sea surface and exporting nutrients to lower latitudes, Southern Ocean circulation supports 75% of global marine primary production.

The Antarctic ice sheets moderate global temperatures by reflecting solar radiation due to the high albedo of snow. They also hold around 70% of the world's freshwater as ice — equivalent to approximately 58 metres global sea level rise.

Antarctica records past climate and environmental change in geological outcrops and in sediment and ice core records.

Ice shelves are essential to the stability of ice sheets in Antarctica, and they are the interface between the ice sheets and Southern Ocean. The Ross Ice Shelf is the world's largest ice shelf, and ocean–ice interactions beneath it are an important regulator of ocean properties.

Antarctica is the only continent with relatively intact ecosystems and from which anthropogenic extinctions have not been recorded. Native ecosystems have adapted to the region's extreme conditions over millions of years but are now challenged by rapid and unprecedented environmental change and increasing human impacts.

Antarctica and the Southern Ocean provide foraging areas for a wide range of species such as seabirds and marine mammals, some of which breed in and migrate through New Zealand.

Antarctica and Southern Ocean physical processes, including wind, sea ice formation, snow cover, ice mass balance and oceanographic circulation are showing increasing variability and altered trends, with long-term and far-reaching consequences for the climate of Antarctica, New Zealand, and the Earth.

New Zealanders and Antarctic and Southern Ocean research

New Zealand has a long association with Antarctica and the Southern Ocean. Early exploration by the Polynesian navigator, Ui-te-Rangiora, in a fleet of waka tīwai ("hollowed-out logs"), revealed an area of ice floes and icebergs in the vastness of the Southern Ocean which he called Te Tai-uka-a-pia ("sea foaming like arrowroot"). Some stories talk of the curiosity of Tamarereti that inspired him to journey to locate the source of the Aurora Australis or Te Tahu-nui-ā-Rangi.

In 1957, Scott Base was established as New Zealand's permanent research station. For more than 60 years, New Zealand researchers have made internationally recognised contributions to a broad range of topics including past and present climate, biodiversity, and environmental monitoring.

Connecting Antarctic and Southern Ocean research with the complementary knowledge systems of te ao Māori is vital. The principles of partnership and mutual respect embodied in the principles of Te Tiriti o Waitangi provide a foundation for these connections; through understanding and respecting mātauranga Māori and science, our knowledge of and relationship with te taiao ("the environment") is enhanced. This knowledge is fundamental to improving the wellbeing of New Zealanders: he tangata, ko Papatūānuku, ko Ranginui, ko Tangaroa, ko Tāne-mahuta.

Meaningful and enduring partnerships with iwi, hapū, researchers and stakeholders will strengthen the conservation of Antarctica and the Southern Ocean.

Guided by manaakitanga[4], New Zealand is committed to preserving and protecting Antarctica and the Southern Ocean for present and future generations. The New Zealand Government recognises Antarctica and Southern Ocean research as integral to understanding global environmental systems and its unique value for scientific research. New Zealand is committed to promoting impactful collaborative scientific research, including to:

- support, lead and share scientific research that increases understanding of the interaction between global systems and Antarctica
- increase New Zealander's awareness of Antarctic issues and advancing climate change policies and capability to respond, and adapt, to change
- be a leader in research in the Ross Sea region Marine Protected Area
- ensure Scott Base is an effective and sustainable facility, providing support for the safe conduct of excellent scientific research.

Funding

The majority of New Zealand's Antarctic and Southern Ocean research effort is supported by government agencies and research organisations which provide funding for science, infrastructure and logistical support. Some research objectives are determined by agencies with specific management or policy responsibilities, while others are driven by issues that emerge from the research community.

[4] In this context, manaakitanga is about enhancing the mana of all: caring for, honouring and respecting ourselves, others and the natural environment. See Statement of Commitment to Antarctica and the Southern Ocean, appended to this document.

Currently Antarctic research funding is supported through the following government Votes, including:

- Vote Business Science and Innovation, which supports research through investments by the Ministry of Business, Innovation and Employment. This encompasses support for a wide range of funding including Strategic Science Investment Funds (e.g., the Antarctic Science Platform), Endeavour Fund and, through the Royal Society Te Apārangi, the Marsden fund.
- Vote Foreign Affairs and Trade, through Antarctica New Zealand, which manages Scott Base and provides logistical support for the majority of New Zealand's research programmes in Antarctica.
- Vote Fisheries, through the Ministry for Primary Industries, which funds research to assist the management of the Ross Sea toothfish fishery and to assist with delivery of research under the Ross Sea region Marine Protected Area Research and Monitoring Plan.
- Vote Education through funding for university staff and students undertaking Antarctic research.
- Vote Defence for capability procurement, and Vote Defence Force for operational support including logistics.
- Vote Lands, through Land Information New Zealand, which provides operational support by maintaining and delivering geodetic surveys, place naming, topographic mapping and hydrographic charting.

Some Crown Research Institutes also contribute funding, equipment and specialised facilities to support Antarctic and Southern Ocean research.

Logistics and Infrastructure

New Zealand Antarctic and Southern Ocean research uses a range of assets:

- Since 1957, New Zealand has maintained Scott Base as its year-round research station on Ross Island.
- New Zealand's deepwater research vessel RV *Tangaroa* undertakes ocean and atmospheric research in the Ross Sea region.
- New Zealand Defence Force assets include the C-130H Hercules and Boeing 757 aircraft for intercontinental airlift, the HMNZS Aotearoa for resupply, P-3K2 Orion aircraft for maritime surveillance aircraft, and Offshore Patrol Vessels.
- Helicopter and ski-fitted fixed-wing aircraft support field research activities in Antarctica.
- Over-ice traverse capability supports remote work.

- Joint logistics arrangements with other National Antarctic Operators in the Ross Sea region to support scientific research initiatives.
- Vessels of opportunity including the New Zealand fishing industry in support of Southern Ocean research and management objectives.
- Specialised equipment for drilling, diving, and airborne, oceanographic, atmospheric and sub-ice shelf measurements, and monitoring stations for environmental and ecological observations.

International connections

Within the cooperative framework of the Antarctic Treaty, strong national and international collaborations are fundamental to assembling world class, interdisciplinary teams, helping programmes to reach a critical mass, sharing the costs of research and logistics, and lending weight to policy advice. New Zealand researchers play a major role in international Antarctic research initiatives. New Zealand's Antarctic and Southern Ocean science will continue to be aligned with and well connected to relevant international initiatives over the next decade. New Zealand's longstanding scientific and logistic partnership with the United States, as neighbours on Ross Island, is highly valued.

New Zealand has collaborative relationships with other nations active in Antarctica, in particular those that operate in the Ross Sea region. It is important that New Zealand continues to explore opportunities to cooperate with other Antarctic Treaty Parties for mutual benefit.

The Scientific Committee on Antarctic Research (SCAR) is a thematic organisation of the International Science Council (ISC). SCAR is charged with initiating, developing, and coordinating high quality international scientific research in Antarctica and the Southern Ocean, and on the role of the Antarctic region in the Earth system. New Zealand researchers continue to play leading roles in a range of SCAR initiatives.

Antarctica New Zealand is an active Member of the Council of Managers of National Antarctic Programs (COMNAP) whose Secretariat is based in New Zealand, and whose purpose is to develop and promote best practice in managing the support of scientific research in Antarctica.

The Antarctic Treaty System

New Zealand is one of 12 original signatories to the 1959 Antarctic Treaty, which applies to the area below latitude 60° south. The Antarctic Treaty Parties have committed to the comprehensive protection of the Antarctic environment and to ensuring that Antarctica shall continue forever to be used exclusively for peaceful purposes and science.

Since the Antarctic Treaty was agreed, the Parties have negotiated a number of additional international treaties which collectively form the Antarctic Treaty System including the 1980 Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) and the 1991 Protocol on Environmental Protection to the Antarctic Treaty (the Protocol).

Pressures on Antarctic environments are increasing as a consequence of changing climate, atmospheric and oceanic conditions as well as expanding human activities there including research, tourism and fishing. The Antarctic Treaty Parties and CCAMLR Members depend upon the best available science to inform their work.

New Zealand's Antarctic and Southern Ocean research supports New Zealand's leadership in, and contributes to strengthening, the Antarctic Treaty System.

Policy Drivers

New Zealand's Statement of Commitment to Antarctica and the Southern Ocean (link) emphasises that New Zealand's environment is connected to Antarctica and the Southern Ocean. This commitment includes supporting, leading and sharing scientific research that increases understanding of the interaction between global systems and Antarctica, and that aligns with and advances New Zealand's climate change policies and ability to adapt to variability and change and supports the conservation of Southern Ocean ecosystems.

The following policy drivers, which are linked to the priorities in the following section, are not exhaustive, but are important in shaping New Zealand's research directions and priorities:

- The Paris Agreement provides for the strengthening of scientific knowledge on climate, including research, systematic observation of the climate system and early warning systems, in a manner that informs climate services and supports decision-making.
- New Zealand Antarctic research feeds directly into knowledge gaps identified by the Intergovernmental Panel on Climate Change (IPCC):
    - The IPCC Special Report of the Ocean and Cryosphere (2019) identifies a low level of confidence in interpretations of physical observations of Antarctic and Southern Ocean change, given the poor spatial and temporal resolution of in situ records and large interannual to interdecadal variability.
    - The AR6 IPCC Report published at the outset of the 2021-2030 period made it clear that Southern Ocean and Antarctic biophysical systems are central to the trajectory of future climate change.
    - The largest uncertainty in IPCC sea level rise projections comes from an ongoing lack of understanding of the key rate-determining processes that control the mass balance of Antarctica's marine-based ice sheets. Better understanding the uncertainty and reducing it, is a high priority to World Climate Research Programme (WCRP) and SCAR. The Antarctic Treaty Parties, IPCC, WCRP and SCAR have noted that critical gaps remain in our understanding of changes and trends in Antarctic sea-ice, and the connections and interactions between the atmosphere, the Southern Ocean and the cryosphere.
    - The IPCC and World Climate Research Programme (WCRP) has also identified that the role of the Southern Ocean in modulating the effects of anthropogenic CO2 emissions and the implications for global climate and the Southern Ocean ecosystems needs to be better understood.
- In support of the Antarctic Treaty system, research is required to enhance New Zealand's commitment to:
    - developing, implementing and strengthening international rules to ensure the comprehensive protection of Antarctic and Southern Ocean biodiversity
    - advocating for the establishment, protection and management of representative and special areas in Antarctica and the Southern Ocean
    - leading research and monitoring in the Ross Sea region Marine Protected Area
    - taking precautionary and ecosystem approaches to the conservation and sustainable management of marine living resources in the Southern Ocean, particularly in the Ross Sea
    - contributing to the research, monitoring and information needs of the Committee for Environmental Protection, in particular the Committee's climate change response work programme, and the Scientific Committee of the Convention on the Conservation of Antarctic Marine Living Resources.
    - As a party to the Montreal Protocol, New Zealand is committed to research, measurement and reporting of stratospheric ozone depletion. This commitment is reflected in New Zealand's Ozone Layer Protection Act 1996.
    - Support New Zealand's Antarctic Science Platform, National Science Challenges and MBIE's Endeavour fund where Antarctic and Southern Ocean data are required to meet policy inputs and to improve regional- and national-scale projections of future change.

Research Directions and Priorities

New Zealand Antarctic and Southern Ocean research will improve our knowledge of past and present Antarctic climates, environments ecosystems. Research outcomes will better constrain models and projections of future change, and enhance our understanding of the sensitivity of Antarctic environments and biota to human impacts, including changing climate and oceanic conditions and the consequences of changes in Antarctica for global ecosystems.

The priorities identified below are strongly interconnected. Significant benefits arise from research that integrates across more than one priority. Greater scientific value and impact results from multidisciplinary approaches to research questions, including drawing on all fields of research and complementary knowledge systems. Close collaboration between researchers from all disciplines is encouraged.

Funding will be based on the merit of the research in the context of the guiding principles and priorities, and not necessarily equally distributed across priorities. Over time, it will be important that research is undertaken across all priorities. Support for monitoring, social sciences and humanities research will also be considered on this basis, where that work informs the priorities set out below. Fundamental or 'blue skies' research is encouraged and need not necessarily fit the guiding principles or directions outlined in this document.

Quantifying the Antarctic contribution to sea level rise

Accelerating ice loss from marine-based sections of Antarctic ice sheets is contributing to sea level rise around New Zealand and globally. This response is non-linear and the rate of ice loss remains a primary uncertainty in sea level rise projections. The associated global socio-economic and environmental implications of sea level rise dictate that it is of urgent national and international significance to understand the causes and rates of ice sheet melting alongside the impacts of change.

Outcomes

- Improve understanding of Antarctic and Southern Ocean influences on New Zealand's land, ocean and climate.
- Quantify and reduce uncertainties in future climate and sea level projections for Antarctica and New Zealand.
- Reduce uncertainties and improve understanding of key physical rate-determining processes in Antarctica and the Southern Ocean.
- Support the Government's climate change-related mitigation and adaptation policies and inform New Zealand's position in international climate change negotiations.

Research goals

To achieve these outcomes, research is required to:

- better understand the linked cryosphere-ocean-atmosphere-lithosphere processes regulating the state and behaviour of Antarctic ice-sheets and ice shelves under past, present and future climate conditions


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- understand processes of ocean-cryosphere interaction and ocean circulation processes beneath ice shelves and connections to ice sheet/shelf behaviour and Southern Ocean processes
- inform projections of Antarctica's contribution to regional, New Zealand and global sea level rise
- identify thresholds of irreversible ice shelf and/or ice sheet collapse

Links

- SCAR's Scientific Research Programme (SRP), Instabilities and Thresholds in Antarctica (INSTANT) aims to quantify the Antarctic ice sheet's contribution to past and future global sea-level change. It will be important to ensure connections with this SRP and other relevant SCAR Expert and Action Groups. SCAR Horizon scan questions 24 to 34 are also relevant to this research priority.
- The World Meteorological Organisation (WMO) has developed a number of programmes pertinent to this priority including the Global Climate Observing System (GCOS) and has sponsored the World Climate Research Programme (WCRP). It will be important to maintain and enhance connections to these programmes.
- The Expert Group on Ice Sheet Mass Balance and Sea Level (ISMASS) co-sponsored by SCAR, the International Arctic Science Committee (IASC), and the WCRP Climate and Cryosphere Project is an important connection.

Cryosphere–ocean–atmosphere connections and implications of change

The Southern Ocean has modulated increases in global atmospheric carbon dioxide and temperature and has been disproportionately affected by these changes. The Southern Ocean is absorbing as much as 75% of human-induced warming and 40% of the global ocean up-take of anthropogenic carbon dioxide. The increased acidity of the Southern Ocean, along with changes in temperature and salinity, have profound implications for marine living organisms as well as circulation patterns. Understanding the impacts of physical and biological interactions between the cryosphere, ocean and atmosphere is critical to inform on drivers of change and the regional and global impacts.

Outcomes

- Improve understanding of cryosphere–ocean–atmosphere connections and processes that inform regional and global models to better constrain projections of future change.
- Improve understanding of Southern Ocean processes, including the Antarctic Circumpolar Current, and the implications of changes in those processes for the Ross Sea region and for New Zealand.
- Improve ability to understand the implications of ocean change for marine living resources and ecosystems.
- Support the Government's climate change-related mitigation and adaptation policies.

Research goals

To achieve these outcomes, research is required to:

- enhance understanding of cryosphere-ocean–atmosphere interactions, in particular uptake of heat and carbon dioxide in the Southern Ocean and its implications for climate and ecosystems
- better understand sea ice distribution and volume and the processes influencing sea-ice formation, drift and decay, to enhance projections of sea-ice changes and improve understanding of the implications of those changes
- enhance understanding of the role of sea ice, polynyas and meltwater on controlling the flux of heat, carbon and salt between the ocean-atmosphere and implications for ice sheet stability
- improve knowledge of ocean heat transport including how freshwater feedbacks influence melt rates under ice shelves and at grounding lines
- better understand past, present and future ocean processes and conditions to provide context for a warming [+2°C] world, testing models and initialising models used to make future projections
- improve understanding of atmospheric processes and the implications of changes in those processes for the Ross Sea region and for New Zealand
- better understand the connections between ozone recovery, global atmospheric circulation change and Antarctic weather systems.


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Links

- The priorities identified in this priority are also linked to those identified in the priority Ecosystem dynamics and responses to change. Understanding the implications of changing atmospheric and oceanic conditions for Antarctic and Southern Ocean ecosystem processes and biota is critical.
- SCAR's Scientific Research Programme (SRP) Near-term Variability and Prediction of the Antarctic Climate System (Ant-Climnow) aims to improve predictions of near-term conditions in the Antarctic climate system on timescales of years to multiple decades. It will be important to identify connections with this SRP and other relevant SCAR Expert and Action Groups. SCAR Horizon scan questions 1 to 23 are relevant to this research priority.
- WMO has developed a number of programmes pertinent to this priority including the Global Atmosphere Watch Programme (GAW), the integrated Global Greenhouse Gas Information System (IG3IS), the Global Climate Observing System (GCOS), Global Ocean Observing System (GOOS) and has sponsored the World Climate Research Programme (WCRP), including the WCRP Coupled Model Intercomparison Project. It will be important to maintain and enhance connections to these programmes.
- The SCAR and SCOR (Scientific Committee on Ocean Research) co-sponsored Southern Ocean Observing System (SOOS) and associated international observation networks and data management systems including the International ARGO Ocean Observing Network are also important connections.

Ecosystem dynamics and responses to change

Antarctic biota displays high levels of endemism and adaptation to extreme high latitude environmental conditions. There is a pressing need to improve our knowledge of the natural processes, dynamics and biogeographic structure and functioning of Ross Sea region terrestrial (including aquatic) and marine environments and their biota and crucially to understand their vulnerability to climate change and direct human impacts.

Outcomes

- Improve understanding of ecosystem structure and functioning and vulnerability to change.
- Reduce uncertainties in biodiversity status projections and ecosystem resilience.
- Establish ecosystem monitoring programmes.
- Establish mitigation strategies for non-native species invasion.
- Deliver informed management and policy actions effectively through the Antarctic Treaty System.

Research goals

To achieve these outcomes, research is required to:

- better understand biogeographic structuring, processes, genetic biodiversity and biogeochemistry of terrestrial and marine ecosystems and the drivers of variability and change
- enhance projections of ecosystem vulnerability and response to changing environmental conditions and direct human pressures

- understand the resilience and adaptation of Antarctic species to changing environmental conditions
- understand how Antarctic soil, substrates, inland waters, permafrost and the associated microbial communities will respond to changing environmental conditions and the implications of those changes, including for native biodiversity and ecosystems
- improve understanding of the risks and implications across all environments of invasion and establishment of non-native species, as well as the risks and implications of human-mediated transfers of native biota
- better understand environmental impacts on migratory species including those that breed in or around New Zealand.

Links

- SCAR's Scientific Research Programme (SRP), Integrated Science to Inform Antarctic and Southern Ocean Conservation (Ant-ICON) aims to facilitate and coordinate high quality science to support improved management of and conservation outcomes for Antarctic and Southern Ocean environments. It will be important to ensure connections with this SRP, and other relevant SCAR Expert and Action Groups. SCAR horizon scan questions 43 to 45, 48 to 52, 55, and 57 to 65 are all relevant to this research priority.
- The Committee for Environmental Protection's science needs and priority environmental issues.
- The data collected and managed by CCAMLR and the SCAR and SCOR co-sponsored Southern Ocean Observing System are important connections.

Protecting Antarctic and Southern Ocean environments

The Antarctic Treaty Parties are committed to the comprehensive protection of Antarctic environments and dependent and associated ecosystems and have designated Antarctica including the Southern Ocean as a natural reserve devoted to peace and science. Natural and anthropogenic changes to Antarctic environments, coupled with the increase in human activity and diversification of those activities, are putting pressure on that commitment. New Zealand's research effort, guided by manaakitanga, is vital to continue to preserve and protect Antarctica and the Southern Ocean for present and future generations.

Outcomes

- Deliver informed management and policy actions effectively through the Antarctic Treaty System and include:
  - establishment of a representative network of marine and terrestrial protected areas that serve to enhance ecosystem structure and functioning, resilience and adaptation
  - an effective Ross Sea region Marine Protected Area that meets its objectives and informs the design and management of other Southern Ocean marine protected areas
  - support for CCAMLR to incorporate the implications of environmental change into its ecosystem-based management approach
  - improved understanding of the state of Antarctic environments.

Research goals

To achieve these outcomes, research is required to:

- improve understanding of and reporting on the state of and pressures on Antarctic and Southern Ocean environments, ecosystems, species and values
- improve understanding of terrestrial, including inland aquatic, and marine environments and biota at risk of non-native species introduction, climate change and human impacts including contamination and physical disturbance
- identify practical solutions to mitigate risks to Antarctic and Southern Ocean environments, ecosystems, species and values and measure the effectiveness of response actions
- support the establishment, research, monitoring and management of marine and terrestrial protection mechanisms including Marine Protected Areas and Antarctic Specially Protected Areas
- implement research and monitoring programmes that support the delivery of environmental protection and conservation objectives of the Antarctic Treaty system
- better understand the populations, dynamics and life habits of harvested marine species, the impacts of harvesting them (including impacts on non-target species) and food webs associated with harvested species
- understand how changing oceanic conditions affect harvested species and the implications for managing marine resources in accordance with CCAMLR objectives.

Links

- SCAR's Scientific Research Programme (SRP), Integrated Science to Inform Antarctic and Southern Ocean Conservation (Ant-ICON) aims to facilitate and coordinate high quality science to support improved management of and conservation outcomes for Antarctic and Southern Ocean environments. It will be important to ensure connections with this SRP and other relevant SCAR Expert and Action Groups, including the SCAR Standing Committee on the Humanities and Social Sciences (SC-HASS). SCAR Horizon scan questions 66 to 68, and 74 to 80 are relevant to this research priority.
- The Committee for Environmental Protection's science needs and priority environmental issues.

Reviewing the directions and priorities

These directions and priorities will need to evolve to reflect emerging knowledge and policy drivers. An evaluation of the performance of New Zealand's Antarctic and Southern Ocean research will be undertaken periodically to inform a review of these directions and priorities to take place no later than 2026.


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Annex: New Zealand's Statement of Commitment to Antarctica and the Southern Ocean

Antarctica has intrinsic value as a natural reserve, devoted to peace and science. New Zealand, guided by manaakitanga, is committed to preserving and protecting Antarctica and the Southern Ocean for present and future generations. New Zealand's environment is connected to Antarctica and the Southern Ocean. We prioritise the environmental protection of Antarctica and the Southern Ocean; we value healthy and productive ecosystems; and we are committed to protecting biodiversity. We will:

- Follow environmental best practice in our activities in Antarctica and the Southern Ocean.
- Advocate for the establishment, protection and management of representative special areas in Antarctica and the Southern Ocean.
- Take precautionary and ecosystem approaches to the conservation and sustainable management of living marine resources in the Southern Ocean, particularly in the Ross Sea, supporting strong environmental standards and sustainable economic benefits, and contributing to scientific understanding.
- Be an international leader in efforts to eliminate illegal, unreported and unregulated fishing in the Southern Ocean.

Antarctica is an essential part of understanding global environmental systems, and is uniquely valuable for scientific research. We are committed to promoting and collaborating on scientific research of the highest standards. We will:

- Support, lead and share scientific research that increases understanding of the interaction between global systems and Antarctica, and advances New Zealand's climate change policies and capability to respond to change.
- Be a leader in research in the Ross Sea region Marine Protected Area.
- Ensure Scott Base is an effective and sustainable facility, providing support for the safe conduct of excellent scientific research.

Antarctica is part of New Zealand's heritage, and future. As the gateway to the Ross Sea region we uphold New Zealand's role in Antarctic exploration, scientific discovery and collaboration. We will:

- Celebrate New Zealand's connection with Antarctica and the Southern Ocean; honouring our linkages through scientific research, environmental protection, conservation, heritage and logistical support.
- Strengthen Christchurch's position as the international gateway to the Ross Sea region, ensuring we provide high-quality services to, and collaboration with, other nations.
- Maintain air, maritime and terrestrial assets capable of operating in Antarctica and the Southern Ocean.

New Zealand values a peaceful, secure and safe region. We support the Antarctic Treaty principles and strive to maintain a peaceful, nuclear free and protected Antarctica. We will:

- Actively engage with our Antarctic partners to sustain a strong and effective governance framework under the Antarctic Treaty system.
- Develop and implement international rules to ensure the comprehensive protection of the Antarctic, ensuring its value as a place for peace and scientific research is prioritised, the impacts of human activity are limited, and safety is promoted.

New Zealand Government