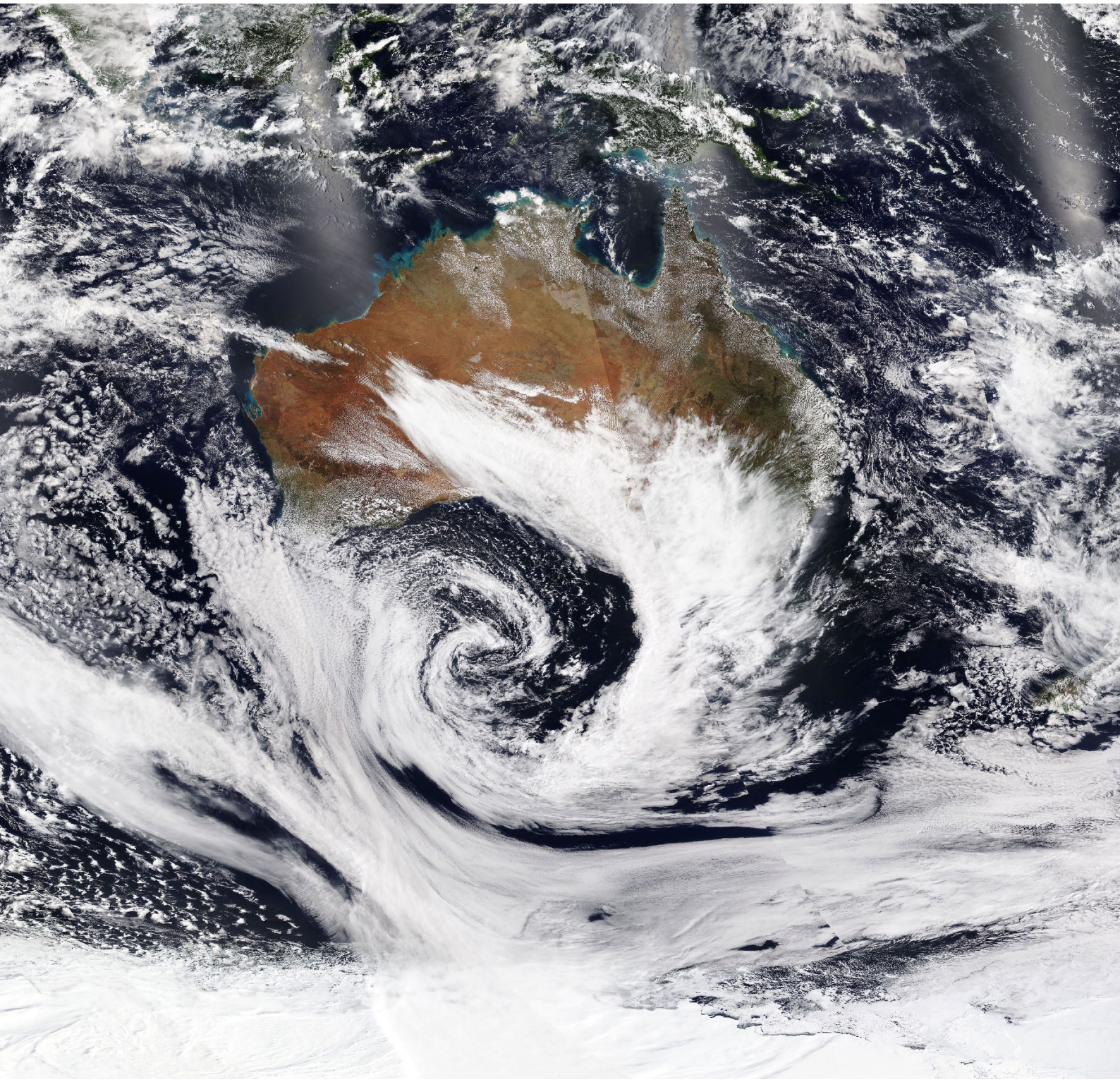
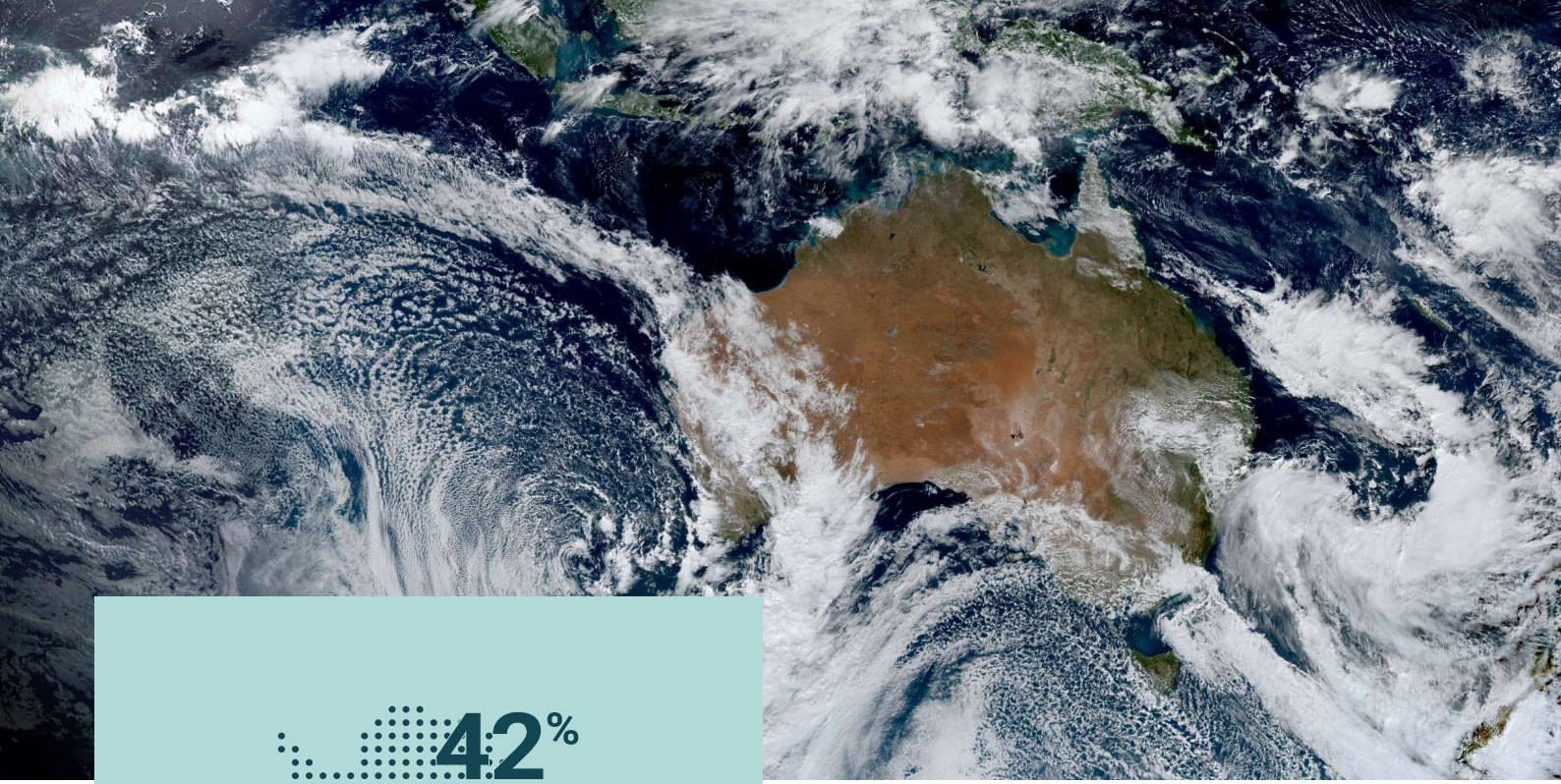
ACEAS
Australian Centre for Excellence in Antarctic Science



Why Antarctica matters to Australia



Australia has strong strategic, historic, and environmental interests in Antarctica, claiming 42% of the continent's territory.

Antarctica and Australia are closely linked, with Antarctica influencing Australia's weather, climate, ecosystems, and coastlines.

The observed changes in Antarctica due to climate change are concerning and have direct implications for Australia.

Introduction

Antarctica has long drawn the interest of explorers, nations, and scientists worldwide. Antarctic expeditions started in the 19th century, driven by discovery and also the desire to exploit resources (whales and seals), understand weather patterns and make territorial claims. In the 20th century, several nations, including Australia, staked claims to parts of Antarctica—with the Australian Antarctic Territory covering 42% of the continent. The existence of the Antarctic territorial claims, with some of them overlapping, led to some geopolitical tension, compounded by the growing Cold War rivalry between the USA and the Soviet Union.

It was science that provided a catalyst for resolving these tensions. The twelve countries that had undertaken Antarctic research in the International Geophysical Year negotiated the Antarctic Treaty in 1959. The Treaty banned new territorial claims, military activity, and nuclear weapons testing, turning Antarctica into a place for peace and scientific cooperation.

Today, Antarctica is a crucial hub for international research, offering insights into past and future climate changes, ocean circulation, and marine ecosystems. As its closest neighbour, Australia plays a key role in the Antarctic Treaty System and is recognised as a global leader in Antarctic research, which is critically important globally and for Australia's national interests: Antarctica influences Australia's weather and climate through changes in oceanic and atmospheric circulation and shapes its coastlines through the melting of its ice sheets and sea level rise. Antarctica's ecosystems are significant both globally and to Australia and will be even more so as increasing climate change impacts fisheries and ecosystems around the world.

Understanding the close ties between both continents is crucial, particularly in the face of climate change. Ice sheets are melting significantly, and sea ice is declining at unprecedented rates in Antarctica. These changes will impact Australia's weather, climate, coastlines and ecosystems.

Here, we explore the strong connections between the two continents and discuss the implications of Antarctica's rapidly changing environment for Australia.

Antarctica influences Australia's weather and climate

Antarctica shapes Australia's weather and climate through atmospheric patterns like the Southern Annual Mode, the distribution of sea ice, and the storage of heat and CO_2 by the Southern Ocean.

a: The Southern Annular Mode: a major climate pattern influencing Australia's rainfall

In the Southern Hemisphere, strong westerly winds circle Antarctica and are often associated with the west-to-east passage of low-pressure systems and cold fronts across southern Australia. The Southern Annular Mode (SAM) describes the north/south shift of this belt of westerly winds and is a key climate driver influencing rainfall in eastern and southern Australia. The SAM has three phases: neutral, positive, and negative.

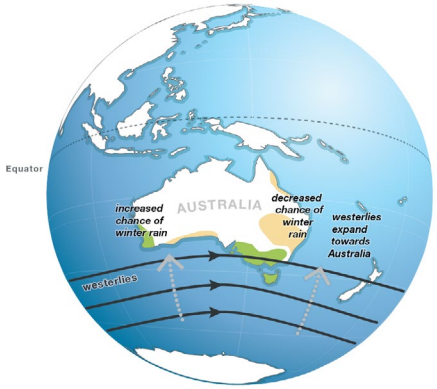
- In a **positive** SAM phase, the belt of westerly winds contracts towards Antarctica, pushing low-pressure systems further south. In winter, this results in fewer cold fronts and drier conditions in southern Australia. In eastern Australia, this southward shift means more moist air can be transported onshore from the east, increasing rainfall over the region in winter and summer.
- In a **negative** phase, the belt of westerly winds shifts northward towards the equator and Australia, leading to more rainfall over south Australia in winter and decreased rainfall for eastern Australia in winter and summer.

b: Antarctic sea ice regulates Australia's climate

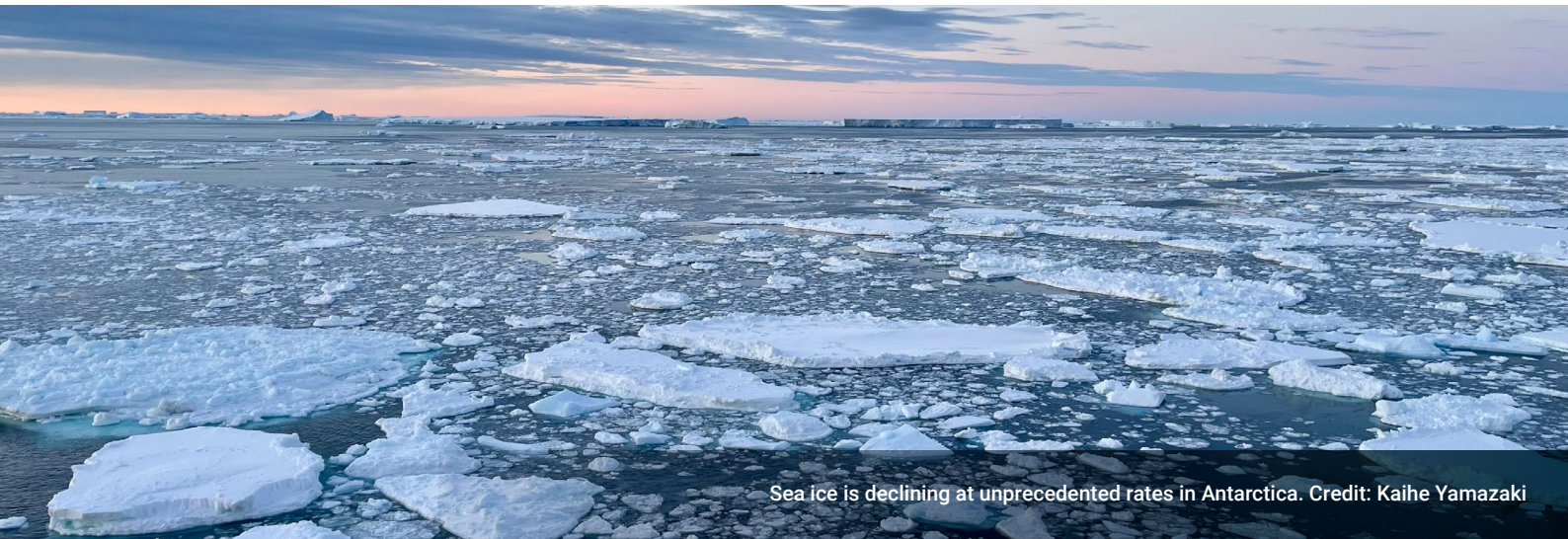
Sea ice is frozen seawater that floats on the ocean surface and forms around Antarctica. Due to its white surface, sea ice reflects most of the incoming sunlight into space, which helps regulate global temperatures. When sea ice declines, darker ocean surfaces are exposed to sunlight, initiating a dangerous feedback loop: dark ocean surfaces start absorbing solar energy, the ocean warms, and even more sea ice melts—keeping the cycle going. Sea ice formation also helps power the Antarctic branch of the meridional overturning circulation (MOC), a global network of ocean currents that redistributes heat, carbon, and nutrients across the globe and plays a key role in regulating the Earth's climate system.

In recent years, Antarctic sea ice has declined at unprecedented rates. In 2023, sea ice was the lowest on record—with a minimum extent of 1.79 million km2—and the second lowest in 2024[1,2]. Further decline in sea ice may intensify warming in Antarctica and beyond, changing temperature gradients and, in turn, affecting atmospheric processes, with significant consequences for Australia's weather (rainfall and temperatures) and climate. Additionally, a decline in sea ice could slow down the Antarctic branch of the MOC, with substantial climatic effects worldwide, including in Australia. The southern and southeastern parts of the country could experience warmer temperatures, and there is some suggestion of both increased and decreased rainfall across the country in response to a slowdown of the circulation[3].

Southern Annular Mode (SAM): **Positive phase (winter)**



Southern Annular Mode (SAM): **Negative phase (winter)**



Sea ice is declining at unprecedented rates in Antarctica. Credit: Kaihe Yamazaki

c: The Southern Ocean: a storage of heat and CO_2

The global ocean absorbs 90% of the excess heat generated by greenhouse gas emissions and 30% of the anthropogenic CO_2 from the atmosphere. The Southern Ocean accounts for 35%-43% of the total global ocean heat uptake and approximately 40% of the total global ocean carbon uptake, making it the planet's largest storage of heat and carbon. This massive uptake helps limit the rise in global temperature and slow the pace of climate change, whose impacts are already seen worldwide, including in Australia. However, this also comes with a cost. As the Southern Ocean absorbs more heat and CO_2, it warms and becomes more acidic. Warmer ocean water causes the ocean to expand and Antarctic land ice to melt, leading to sea level rise. Additionally, warmer ocean water and ocean acidification impact marine ecosystems, disrupting marine food webs and changing species migration patterns and habitats.

d: Antarctic ice cores shed light on Australia's past rainfall patterns and megadroughts

As strange as it may seem, there is a link between rainfall in eastern Australia and sea salt deposits in Antarctic ice cores. The mechanisms behind this link are climate drivers like the SAM or El Niño-Southern Oscillation (ENSO), which are linked to rainfall variability in eastern Australia and simultaneously influence winds that cause sea salt to be lifted from the ocean surface in the Southern Ocean and deposited in Antarctica. Therefore, by studying sea salt levels in ice cores, researchers can detect the presence/absence of these climate drivers for specific periods and infer rainfall patterns in eastern Australia. For example, researchers have used East Antarctic ice core records to study eastern Australia's drought patterns over the past 1,000 years (between 1000 and 2012)[4]. Their findings revealed long wet and dry periods during this time. The dry periods exceeded the lengths of East Australia's three major modern droughts—the Federation Drought, the World War Two Drought, and the Millennium Drought—and occurred several times in the past 1,000 years. In other words, what were thought to be rare and major events like the Federation Drought occurred frequently and lasted longer in the past. These findings are crucial for improving our understanding of future drought risk in eastern Australia.

Antarctica shapes Australia's coastlines

The Antarctic Ice Sheet—the thick layer of ice that covers Antarctica—contains approximately 60% of the world's total freshwater[5], making it the largest potential source for global sea level rise. If the Antarctic Ice Sheet was to melt entirely, sea levels could rise by 58 metres[6].

With warmer ocean temperatures, the Antarctic Ice Sheet is melting rapidly. Large amounts of ice are lost through the melting and collapse of ice shelves—extensions of the Ice Sheet that float on the ocean surface. Ice shelves act as dam walls, holding back the flow of glaciers behind them. As the ocean warms, ice shelves thin and collapse, and the glaciers that feed them accelerate their flow into the ocean, leading to sea level rise.

In the last thirty years, the global mean sea level has risen by around 10.5 cm[7], and a potential sea level rise of 1 meter is expected by the end of the century under a high emission scenario[8], with Antarctic ice loss identified as a major driver of this rise. With 87% of Australia's population living within 50 kilometres of the coast[9], rising sea levels pose a major threat to Australia's coastlines, economy, and communities. In the future, low-lying coastal areas, including major cities like Sydney and Brisbane, could experience more severe and more frequent flooding[10]. Additionally, coastal erosion could increase, threatening coastal infrastructure and beaches, driving up insurance costs, and reducing tourism revenue[10,11]. A sea level rise of 1.1 metres by the end of the century could expose more than $226 billion worth of Australian infrastructure—commercial, industrial, road and rail, and residential—to flooding and erosion hazards[12]. Between 187,000 and 274,000 residential buildings may be at risk, with the replacement value of these assets ranging between $51 and $72 billion dollars[13].

Aerial drone view of Collaroy Narrabeen Beach on the Northern Beaches of Sydney, NSW. Credit: Steven Tritton

Antarctic ecosystems are vital to Australia

The Southern Ocean is home to more than 9,000 marine species, many of which are found nowhere else in the world. As one of the nearest landmasses, continental Australia shares many marine species with Antarctica. An example is the humpback whale, which migrates from Antarctica to the Australian waters from June to August and returns to the Southern Ocean from September to November.

The migration of humpback whales is a major attraction for domestic and international tourists, with locations on the east coast such as Byron Bay and Sydney benefiting from whale-watching tours yearly. Together with the emperor penguins, seals, and other iconic Antarctic species, they also attract many tourists to Antarctica, with Hobart serving as a key gateway for Antarctic expedition cruises and scientific voyages. Antarctic ecosystems and species are also significant to Australia's fisheries, with many commercially fished species like the Patagonian toothfish and Mackerel ice fish inhabiting the waters of the Southern Ocean. Antarctic tourism and fisheries are each valued globally at US $1 billion annually[14].

Australia has a special role in understanding, monitoring, and preserving Antarctic ecosystems, particularly in the face of climate change. Antarctic ecosystems depend on the abundance of Antarctic krill, a tiny shrimp-like crustacean, which forms the basis of the Southern Ocean's marine web and provides food for most of the larger animals, including fish, seals, penguins, seabirds, and whales. Climate change and declining sea ice impact the distribution and abundance of Antarctic krill, destabilising the whole Antarctic food web. This could in turn have significant consequences for Antarctic ecosystems and fisheries over the coming decades.

Antarctica's future matters to Australia

Antarctica's changing environment will significantly impact Australia. Unless global greenhouse gas emissions are drastically reduced, Antarctic glaciers and ice sheets will continue to melt, and sea ice will decline further. These changes will impact Australia's weather and climate, and contribute to rising global sea levels, threatening Australia's coastal cities and communities. Further decline in sea ice will drive habitat loss for key marine species in Antarctica and the Southern Ocean, and affect Antarctic krill, impacting the entire Antarctic food web and the fisheries that rely on them.

With retreating ice sheets and melting sea ice, some areas of Antarctica may become more accessible, increasing the risk of countries or companies wanting to prospect for mineral resources. However, other areas may become more difficult to access due to shallower seafloor depths driven by land-ice melt driving bedrock uplift, or the creation of new navigation barriers caused by icebergs grounding on the shallower ocean floor. Australia was a key proponent of the 1991 ban on Antarctic mining. Maintaining Australia's presence in Antarctica, its key role in the Antarctic Treaty System, and its global leadership in Antarctic research will be vital for addressing these future challenges.

Antarctica is not only a place of strategic, environmental, and scientific importance for Australia but also one of unique wonder. As a steward of the Australian Antarctic Territory, Australia has a strong responsibility to value, understand, and protect the future of this extraordinary continent.

Explainer

Understanding the Antarctic Treaty

In the 19th century, the potential for whaling, sealing, and mineral resource exploitation attracted many nations to Antarctica. Seven countries, including Australia, made territorial claims to parts of the continent in the 20th century. Australia's claim, the Australian Antarctic Territory, covers 42% of the continent, making it Antarctica's largest territorial claim. Amid growing tensions surrounding these claims and growing Cold War rivalries between the Soviet Union and the USA, twelve nations, including the claimant states, Australia, Argentina, Chile, France, Norway, New Zealand, and the UK, agreed to the Antarctic Treaty in 1959. By banning new territorial claims and military activity on the continent, the Treaty ensured the use of Antarctica for peaceful purposes only, guaranteed freedom of scientific investigation, and promoted international scientific cooperation. In 1991, the Environmental Protocol was signed as part of the Antarctic Treaty System —the broader framework of agreements, including the Antarctic Treaty— and further banned mining activity on the continent.

Today, the Antarctic Treaty includes more than 50 countries. As one of the original signatories of the Treaty and due to its strategic location and large territorial claim, Australia plays a central role in the Antarctic Treaty System The country is a global leader in Antarctic research and collaborates with many international teams. Beyond science, the Antarctic Treaty also benefits Australia's national security by stating that all regions south of 60°S latitude must remain non-militarised. As a result, Australia does not need to focus on the defence of its southern border.

Image: Countries participating in the Antarctic Treaty.
Credit: British Antarctic Survey.

Installing GPS on Sorsdal Glacier. Credit: Sue Cook

Explainer

The importance of Antarctic research

Australian Antarctic research is crucial for understanding Antarctica's influence on weather and climate in Australia, and it provides essential information for Australia's national interests, driving the country's preparedness to address future climate challenges.

Australia is actively involved in Antarctic research through several key groups, including the Antarctic Australian Division (AAD), the Australian Antarctic Program Partnership (AAPP; 2019-2029), the Australian Centre for Excellence in Antarctic Science (ACEAS; 2021-2026), and Securing Antarctica's Environmental Future (SAEF; 2021-2029). Using multi-disciplinary approaches, these groups collaborate closely to advance Australian Antarctic science.

More than 80% of Australia's Antarctic research is led by or involves university researchers, supported by no more than $20M per year of direct Government funding. This funding is all short-term and terminating.

Australia shows leadership in Antarctic science by conducting major scientific campaigns like the Denman Terrestrial Campaign (2022-2025) and the Denman Marine Campaign (March 2025-May 2025). These significant scientific research campaigns focus on better understanding the Denman Glacier—one of the fastest retreating glaciers in East Antarctica—and provide the evidence base to guide national and global decision-making, and deliver on the priorities in the Australian Antarctic Strategy and 20 Year Action Plan. Australia's research vessel, the icebreaker *RSV Nuyina*, together with aircraft to access remote regions on land, and Australia's permanent research stations in Antarctica—Mawson, Davis, Casey on the Antarctic continent, and the Macquarie Island station—are vital to these campaigns.

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