ACEAS
Australian Centre for Excellence in Antarctic Science

Alarm bells from the south:
an overview of recent Antarctic extremes

Sea ice extent has decreased dramatically since 2017.
Credit: Kaihe Yamazaki

Antarctic change has accelerated over the past five years, with new extremes emerging, including major heatwaves, record-low sea-ice extent and ice shelf collapses.

Warming and ice loss have changed Antarctica's landscape, disrupting its fragile ecosystem and unique species.

Avian influenza has caused significant mortality across some Antarctic and sub-Antarctic locations.

These extremes are consistent with the impacts of a warming climate and may become the norm of tomorrow if warming continues at current rates.

Introduction

For much of human history, Antarctica has been viewed as cold, frozen and enduring. Its ice sheet was thought to change only over thousands of years, posing no real risk to humanity.

While evidence to the contrary has been clear for 25 years, over the last five years, Antarctica has seen an explosion of change, which has significant implications for Australia and the rest of the world.

Here, we summarise these major changes and discuss their causes, why they matter, and what actions are now needed.

Record lows in sea ice extent

Antarctic sea ice extent has been stable since the beginning of satellite records in the 1970s, and even increased during the first part of this century. However, it has dramatically decreased since 2017, breaking record after record. At various times since 2022, sea ice extent was smaller than expected by an area equivalent to Western Australia (Figure 1). Several hypotheses have been put forward to explain these declines, including a warmer upper ocean and changes in wind patterns[1]. A recent study has also shown that increasing salinity in the upper ocean may play a role[2]. Australian scientists believe that the Antarctic sea ice system may have entered a regime shift[1].

These changes have far-reaching implications. Sea ice regulates our climate. Its white surface reflects solar radiation, and its formation helps drive a major global ocean current, the Meridional Overturning Circulation (MOC). Sea ice also serves as a crucial habitat for Antarctic marine life, ranging in size from microorganisms to top predators. If declines continue, substantial disruptions to climate and ecosystems could occur worldwide, including in Australia.

Major heatwaves

In March 2022, much of East Antarctica experienced an unprecedented heatwave, with temperatures 30 to 40°C above normal, setting new monthly temperature records for March (Figure 1). The heatwave was mainly the result of an unusual weather pattern that transported warm and moist air from Australia, but it was likely made 2°C warmer by climate change[3].

The Antarctic Peninsula experienced major heatwaves in 2015, 2020 and 2022, with a record temperature of 18.3°C observed at Esperanza Base during the 2020 event (Figure 1), while Peninsula winter 2026 temperatures reached 15.4°C and were accompanied by rain[4]. Large parts of Antarctica experienced temperatures up to 10°C above normal during the near-record heatwave of July 2024.

Future heatwaves of these sizes and magnitudes are increasingly likely under human-driven climate warming. Changes to the icescape are threatening both the ecosystems and the fieldwork operations that allow scientists to monitor these changes

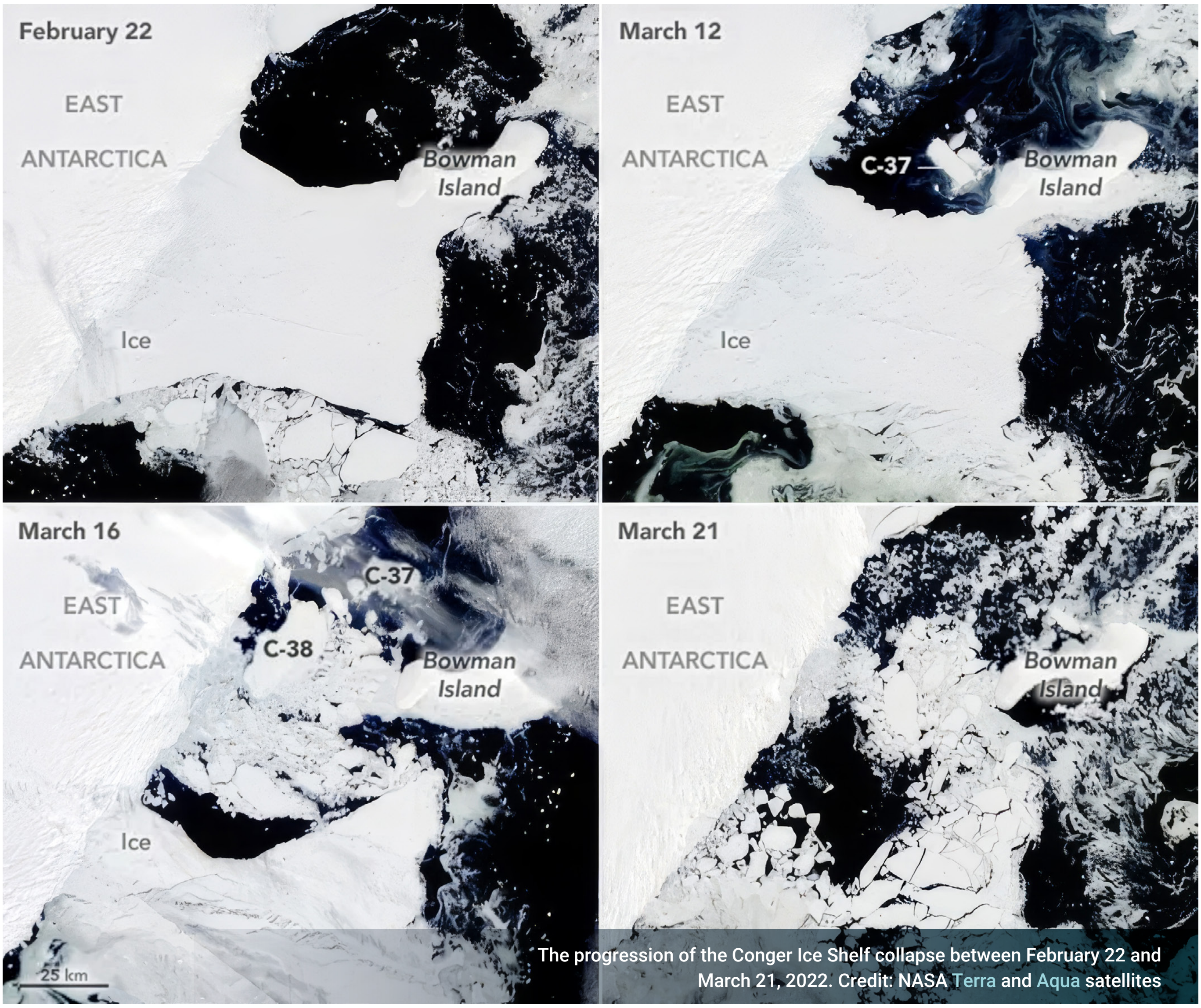
Polar amplification

Heatwaves in Antarctica have occurred against a backdrop of steady warming across much of the continent. Antarctica has warmed by 0.61 ± 0.34 °C per decade between 1989 and 2018 – a warming that is more than three times the global average (Figure 1). This faster rate of warming on the continent compared to the rest of the world is known as polar amplification.

Ice shelf collapse

The Conger Ice Shelf in East Antarctica collapsed in March 2022. This floating extension of land ice had been retreating for 25 years, and the remaining section, equivalent to the size of Brisbane, disintegrated into hundreds of icebergs over just a few days (Figure 1). This event was likely not linked to the heatwave days before.

While this is only the second observed ice shelf collapse in East Antarctica, it follows a series of collapses in the Antarctic Peninsula since the 1990s, likely caused by surface melting and loss of sea ice in front of the ice shelf. With ongoing climate warming, other ice shelves are expected to collapse, including East Antarctica's Shackleton Ice Shelf and West Ice Shelf. Future ice shelf collapses have the potential to to allow faster ice flow into the ocean and raise global sea levels, posing a major risk to coastal communities worldwide.



The progression of the Conger Ice Shelf collapse between February 22 and March 21, 2022. Credit: NASA Terra and Aqua satellites

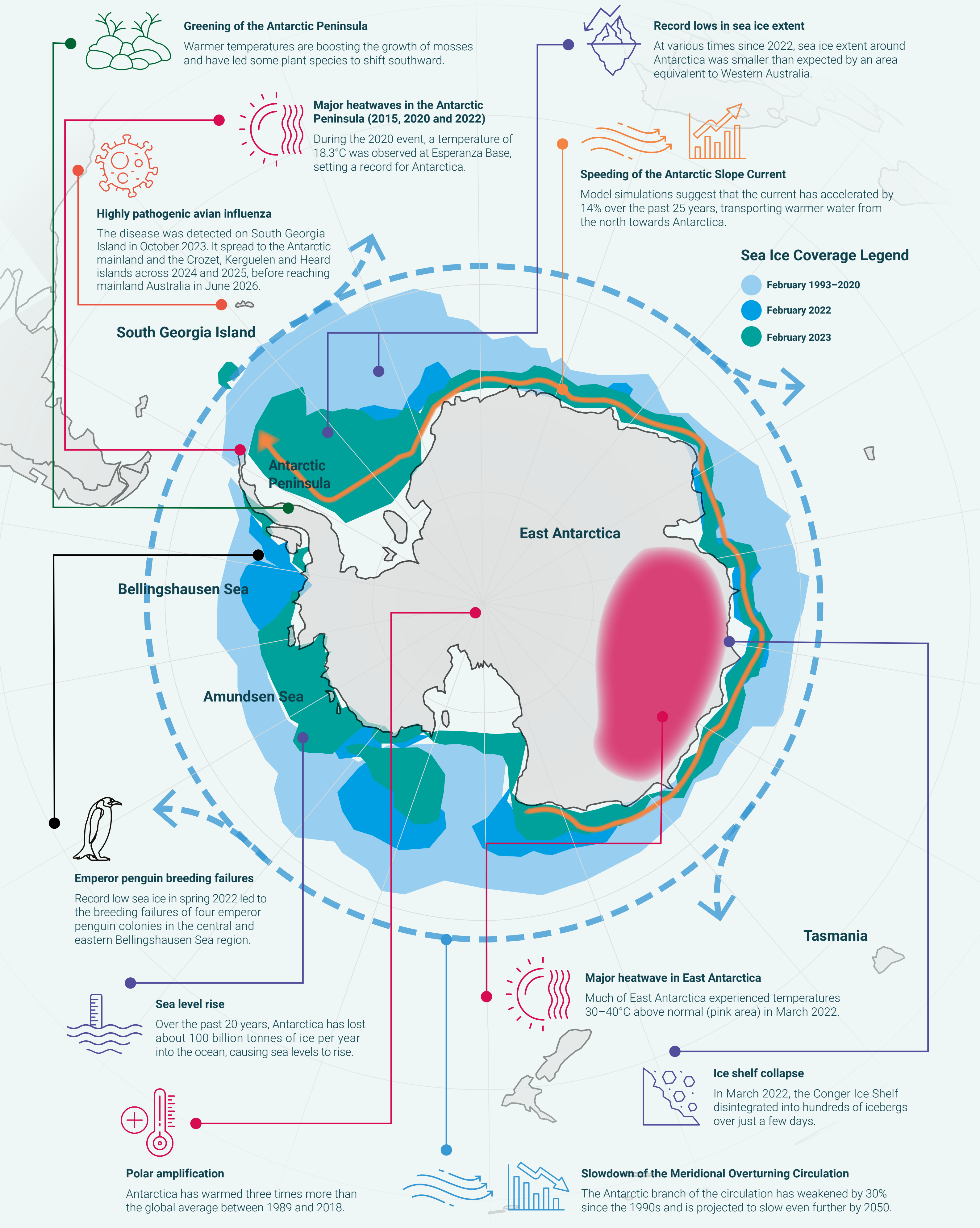


Figure 1. Overview of recent Antarctic extremes. Credit: ARC Australian Centre for Excellence in Antarctic Science

Thwaites Glacier is losing ice at an alarming rate.
Credit: Felton Davis, CC BY 2.0 via Flickr (no changes made)

Sea level rise

The Antarctic contribution to sea level rise has increased since the 1990s. This acceleration was likely associated with a series of strong El Niños in the late 1930s and early 1940s[5], but has since been sustained by climate warming.

Over the past 20 years, the Antarctic continent has lost around 100 billion tonnes of ice each year into the ocean[6] (Figure 1). The most critical region for ice loss is the Amundsen Sea Embayment, and particularly the Thwaites Glacier, which is losing ice at an alarming rate[7]. The future of the Antarctic contribution to sea level rise will depend on the glaciers of the Amundsen Sea Embayment, as well as the large basins in East Antarctica that are vulnerable to ocean warming, including the Aurora and Wilkes subglacial basins within Australian Antarctic Territory.

According to ice sheet and climate model simulations, global sea levels could rise by up to one metre by the end of the century under a high-emissions scenario (relative to 1995–2014)[8], and Antarctic ice loss has been identified as a major driver of this rise.

Slowdown of major ocean currents

a) Meridional Overturning Circulation (MOC)

Also known as the ocean's global conveyor belt, the MOC sustains Earth's climate, ocean life and fisheries. Since the 1990s, the Antarctic branch of the circulation has slowed by 30% due to increased ice shelf melt and changing sea ice conditions[9] (Figure 1). It is projected to slow even further by 2050[10], with lasting consequences for the global climate, ecosystems, fisheries and biodiversity.

b) Antarctic Circumpolar Current (ACC)

Considered the world's strongest ocean current, the ACC acts as a buffer, protecting Antarctica from strong ocean warming at lower latitudes. The current, along with sea ice, also serves as a barrier to invasive species, which make their way to Antarctica on ocean debris[11].

New projections suggest that the ACC could slow by ~20% by 2050 under a high-emissions scenario, driven by increased meltwater from Antarctic ice shelves[12]. A slowdown of the current means warmer water could reach the continent, potentially destabilising its ice shelves and causing them to collapse. A weaker ACC may also open the door to invasive species, posing a risk to unique ecosystems.

Speeding of the Antarctic Slope Current (ASC)

The ASC is another current that flows around Antarctica, shielding it from warm water to the north. Climate model simulations suggest that the ASC has accelerated by 14% over the past 25 years[13] (Figure 1), driven by Antarctic ice melt, and could flow even faster in the future. The ASC flow may become more turbulent, with vigorous whirlpools transporting large amounts of warm water towards Antarctica and driving further melting.

Emperor penguin breeding failures

In spring 2022, emperor penguin colonies in the west of the Antarctic Peninsula experienced catastrophic breeding failures (Figure 1). These were caused by record-low sea ice extent, with some parts of the region having lost 100% of their sea ice in November[14].

Emperor penguin chicks die when their ice platform breaks up before they grow waterproof feathers and can swim. Four of the five colonies in the region experienced total breeding failures.

If warming continues at present rates and sea ice declines further, 90% of emperor penguin colonies will become quasi-extinct by the end of the century[15]. This has led to the emperor penguin being classified as Endangered by the IUCN Red List of Threatened Species in 2026.

Avian influenza

The Antarctic region is usually isolated from infectious disease outbreaks that affect other continents. Yet, in October 2023, the highly pathogenic avian influenza virus (HPAIV) H5N1 was detected in five avian and two seal species on the sub-Antarctic island of South Georgia (Figure 1).

By January 2024, the virus had reached mainland Antarctica, with several detections in Adélie penguins. Later that year, it caused unprecedented mortalities of southern elephant seals on Crozet and Kerguelen islands. In late 2025, the strain was detected on Australia's subantarctic Heard Island, affecting elephant seals, fur seals and gentoo penguins, and in June 2026, H5 bird flu was detected on mainland Australia from an infected brown skua, a sub-Antarctic species of migratory seabird.

The spread of HPAIV H5N1 in the Antarctic region poses a significant threat to its unique wildlife. Many sub-Antarctic islands host large breeding colonies each year, and any H5N1 outbreak has the potential to cause massive die-offs in these dense populations. It is also a likely pathway for further cases of H5 bird flu reaching mainland Australia.

Greening of the Antarctic Peninsula

The Antarctic Peninsula is expected to warm at a rate of 0.34°C per decade until 2100[16]. Glaciers in the peninsula will continue to melt and retreat, exposing new land where vegetation can establish. A warmer ocean may lead to wetter conditions, boosting the growth of mosses and other plants (Figure 1). Greening could lead to significant disruptions to existing ecosystems, modifying the structure of food webs, opening the door to non-native and invasive species, and shifting the range of species found in the region. Some plant species have already shifted southward. There is some evidence to suggest widespread greening may already be underway[17,18].

What is now required?

Most of the extremes presented here have emerged over the past five years. Many were genuine surprises or occurred faster than expected, and most remain not well understood by scientists. However, they are consistent with the impacts of a warming climate, which can either drive major changes or exacerbate ongoing processes. If warming continues at present rates, the 'alarm bells' of yesterday will become the norm of tomorrow.

Looking ahead, it is vital to better understand and anticipate these events. Early detection of changes will be crucial, but it remains challenging due to a lack of long-term observations and a clear understanding of what is natural and what is not. This is why sustained field and remote observations – both now and into the future – are more important than ever. Ultimately, while all these efforts are needed, rapidly reducing CO_2 emissions to as close to zero as possible, or below it, remains the most significant step we can take to mitigate climate change and safeguard Antarctica's future.

Emperor penguin chicks died as the ice platform broke up before they were ready to swim.
Credit: Barbara Wienecke

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