



Antarctica and climate change

According to the IPCC fifth assessment report, it is extremely likely (95-100% confidence) that human activities have been the dominant driver of global climate change since the mid-20th century. Antarctica, and the Southern Ocean that surrounds it, are integral to helping us predict the future of Earth's climate system. Understanding Antarctica's role in climate change is not only a huge scientific challenge but also an urgent priority for society.

What makes Antarctica so important?

The vast, ice-covered Antarctic continent is a major component of the Earth's global climate system. The high contrast in reflective properties of white, ice-covered areas and surrounding dark sea surface in the region plays an important role in regulating regional and global climate. The extremely cold and salty waters around Antarctica sink deep into the ocean, driving a conveyor belt of oceanic heat around the globe. The Southern Ocean is very effective at absorbing the greenhouse gas carbon dioxide from the atmosphere as a result of ocean mixing caused by strong westerly winds around the continent.

Analysis of Antarctic ice cores and marine sediment records reveal that the Antarctic ice sheet has grown and shrunk over geological history. During the past 800,000 years the Earth experienced eight glacial cycles (each with an ice age and a warm period). Understanding this natural rhythm helps scientists get a better picture of what's happening to the Earth's climate today and what might happen in the future.

Is Antarctica warming?

Antarctica covers an area larger than Europe, and so naturally there are marked spatial variations in temperature trends. Many long-term measurements from Antarctic research stations show no significant warming or cooling trends, and temperatures over most of the continent have been relatively stable over the past few decades. However, the Antarctic Peninsula and large parts of West Antarctica warmed significantly over the second half of the 20th century.

Despite warmer sea-surface and air temperatures over the Southern Ocean, there has been a slight increase in Antarctic sea-ice extent which is believed to be linked to changes in atmospheric weather patterns. In contrast, the collapse of ice shelves and land-ice reduction near coastal West Antarctica has been driven by warm ocean currents under the ice shelves.

What are the drivers of Antarctic climate change?

We now know that the Antarctic Ozone Hole has had a profound effect on the Antarctic climate that extends far beyond increasing the levels of ultraviolet radiation. As stratospheric ozone concentrations have fallen, temperatures above the continent have also dropped. This creates a larger temperature difference between the tropics and the Antarctic, which affects Southern Hemisphere weather patterns. For example, since 1980 the strength of winds over the Southern Ocean have increased by about 15%. This has acted to reduce the warming effects of greenhouse gases by influencing Antarctica's atmospheric heat balance; warming by flow inwards from lower latitudes, and cooling by radiating heat out towards space.

Antarctic climate is also influenced by tropical activity. Tropical storms and monsoons create waves high up in the atmosphere which travel to higher latitudes and disturb polar weather patterns. Evidence now suggests that these processes are linked to the observed warming of West Antarctica.

What has caused the collapse of ice shelves around the Antarctic Peninsula?

There have been dramatic changes in climate over the Antarctic Peninsula – the long, mountainous land mass that projects from the main continent. The eastern side of the Antarctic Peninsula is very sensitive to climate change. Stronger westerly winds in the northern Antarctic Peninsula, driven principally by human-induced climate change, were responsible for the marked regional summer warming that led to the well-publicised retreat and collapse of the northern Larsen Ice Shelf. In October 2006, the first direct evidence linking human activity to the collapse of northern Antarctic Peninsula ice shelves was reported by BAS scientists in the *Journal of Climate*.

Climate records from the west coast of the Antarctic Peninsula show that temperatures in this region have risen by around 2.9°C during the past 60 years – about three times the global average – a rise only matched in the Arctic. British Antarctic Survey research has shown also that near-surface sea temperatures to the west of the Peninsula have risen by over 1°C over a similar period. It is now accepted that the waters of the Antarctic Circumpolar Current are warming more rapidly than the global ocean as a whole.

How has human activity contributed?

The Ozone Hole and global warming have changed Antarctic weather patterns such that strengthened westerly winds force warm air eastward over the Antarctic Peninsula's 2km-high mountain chain. On summer days when this happens, temperatures in the north-east Peninsula warm by around 5°C, creating the conditions that favoured drainage of meltwater into crevasses on the Larsen Ice Shelf, a key process that led to its break-up in 2002.

What next?

Over the coming century, despite an expected recovery of ozone amounts, the effects of greenhouse gas increases will likely dominate more and drive further increases in westerly wind strength and warming of Antarctica.

It is important that society and political leaders have access to the best scientific evidence and understanding of the likely scale and impact of global climate change. Attributing observed changes to either natural environmental events or to human activity requires reliable observations of past and present climate. A great deal of international effort is focused on using and improving sophisticated climate models to produce better predictions of future change.

FACTFILE

- The mean annual temperature in the Antarctic Peninsula has risen by up to 3.2°C in the past 60 years contributing to the collapse of some of the smaller ice shelves.
- Around 30 countries operate Antarctic research stations where scientists study global environmental issues like climate change, ozone depletion and sustainable management of marine life.
- There is clear evidence for climate change from many sources including: globally averaged air and ocean temperatures, reductions in most glaciers, acidification of the oceans and sea-level rise caused by thermal expansion and ice melt.
- Unequivocal evidence has shown that since the start of the Industrial Revolution the amount of greenhouse gases entering the atmosphere has increased beyond that caused by natural events.
- The present concentration of atmospheric carbon dioxide exceeds any value measured in ice cores covering the last 800,000 years.



Antarctica is vital for understanding climate change

