Australian Government
Department of the Environment, Water, Heritage and the Arts
Australian Antarctic Division

FACTS ABOUT ICE SHEETS

Is the Antarctic ice sheet growing or shrinking?

The findings of the Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC AR4), in 2007, was that the Antarctic Ice Sheet, as a whole, was contributing to sea level rise at a rate 0.2 mm/yr. Ice loss occurred mostly from increased discharge of icebergs by large outlet glacier systems in the Amundsen Sea and Bellingshausen Sea regions of West Antarctica. Loss also occurred by melt along the Antarctic Peninsula, where air temperatures have warmed over the last 50 years.

Since late 2005 (the cut-off date for work assessed by IPCC AR4), further studies of ice accumulation and loss ('mass budget') in Greenland and Antarctica have been made using satellite altimetry, satellite gravity measurements and estimates of the difference between net snowfall and discharge of ice. These confirm that both the Greenland and Antarctic ice sheets are losing ice mass and contributing to sea level rise.

These new estimates suggest that the total annual loss from Antarctica since 1993 is around 100 Gt/yr (100 billion tonnes of ice per year; equivalent to ~0.25 mm/yr of global sea level rise). While the range of estimates from the different studies is large (from near zero to 0.5 mm/yr of sea level rise) they all suggest a net loss. Ice loss has been greatest along coastal sectors of the Antarctic Peninsula and West Antarctica. However, ice thickening (gain) further inland and over most of East Antarctica may have partially offset this loss. All of the available estimates, however, show that the loss of mass in West Antarctica is greater than any added mass in East Antarctica.

What about the Greenland Ice Sheet?

In Greenland the average ice mass loss since 1993 has been about 120 Gt/yr (contributing ~0.35 mm/yr to sea level rise). There is evidence that the rate of mass loss may be increasing, with recent values as high as 0.5 mm/yr of sea level rise. However there can be large variability from year to year in the surface melt in Greenland and the short term changes, from satellite gravity data in particular (which are only available since 2003), may reflect this, rather than a long-term trend. There has been thickening of the high central ice sheet in Greenland, but this has been more than offset by increased melting near the coast. Flow speed has also increased for some Greenland outlet glaciers.

Why is Antarctic ice melting faster over the Peninsula and in West Antarctica than in East Antarctica?

The Antarctic Ice Sheet is complex, and different regions respond differently.

Ice loss by melting along the Antarctic Peninsula is a direct result of warming air temperature. The rate of temperature rise in this region (2.5ºC over the last 50 years) is among the greatest on our planet.

Increased ice discharge from glaciers is, in some cases, a result of the collapse of floating ice shelves. In the more northerly parts of the Antarctic Peninsula, large ice shelves are eroded from beneath by warming ocean waters, and a number of these ice shelves have catastrophically disintegrated. Although the collapse of a floating ice shelf does not add to sea level, the removal of buttressing by the ice shelves may “unplug” land-based glaciers behind the former ice shelves, and these can then flow more rapidly into the sea.

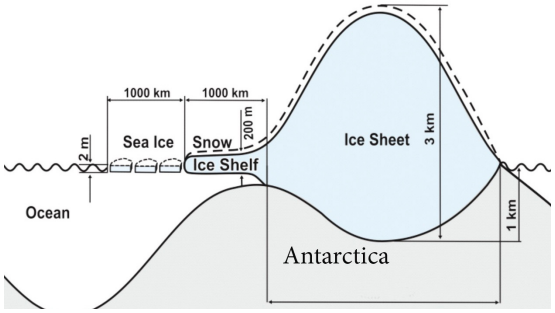
The cause of acceleration of other large outlet glaciers in West Antarctica is not fully understood, but may be related to marine ice shelf instability (discussed under the next question).

Over most of East Antarctica surface temperatures are well below the freezing point, and a small increase in temperature cannot initiate melt. Warmer temperatures, however, allow the atmosphere to hold more water vapour, and thus lead to increased snowfall. An increased input of snow may be causing East Antarctica to grow slightly, but any gain here is more than offset by loss from West Antarctica and the Antarctic Peninsula.

Could the West Antarctic ice sheet continue to add to sea level rise?

The West Antarctic ice sheet forms what is called a marine ice sheet – the ice is resting on bedrock, but that bedrock is below sea level. This is comparable to loading too many ice cubes in your gin and tonic - the bottom one touches the bottom of the glass even though it’s well below the water level.

Where the bedrock under a marine ice sheet slopes down towards the interior, such as under parts of West Antarctica, the ice sheet may be unstable. If the coastal part of the ice sheet thins, it will start to float and is then able to flow more rapidly. This drains more ice from further inland which may also start to float and, with bedrock that slopes backwards and becomes deeper further in, continued retreat of the grounded ice sheet may proceed very rapidly. A small retreat could in theory destabilize the entire West Antarctica ice sheet, leading to rapid disintegration.



Schematic showing the relationship between ice sheets, attached to the continent, ice shelves, attached to the ice sheet but floating in the ocean, and sea ice, formed when the ocean surface freezes. Photo: IPCC AR4

See our related fact sheet on sea level rise for further information