



Australian Government

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

FACTS ABOUT SEA LEVEL RISE

What will be the contribution of the ice sheets to future sea level rise?

The Intergovernmental panel on Climate Change Fourth Assessment Report (IPCC AR4, 2007) projected that sea level rise from thermal expansion of the ocean, melt of small glaciers and ice caps, and from the Greenland and Antarctic ice sheets (for a wide range of emission scenarios) would be in the range 0.18 to 0.59 m by 2090-2100. This estimate does not include further accelerated discharge from ice sheet outlet glaciers.

The ice sheet contribution to this estimate comes mostly from melt in Greenland and from the Antarctic Peninsula. Surface temperatures over most of East Antarctica are well below the freezing point and direct melt of the East Antarctic ice sheet is not expected to contribute significantly to sea level rise over the next century.

Estimating any extra sea level rise from further acceleration of outlet glaciers is not straight forward. Processes such as those controlling basal sliding of glaciers (where lubricating water at the bed of the glacier allows it to move more rapidly) are not well understood. The IPCC AR4 estimated that dynamic ice sheet accelerations

from processes such as marine ice sheet instability and accelerated basal sliding might add another 0.1 to 0.2 m of sea level rise over the next century. But the AR4 report emphasized that even larger values might be possible.

Are reports of sea level rise of 6m correct?

With recent observations of the speed-up of some glaciers in both Greenland and Antarctica, it has been argued that the IPCC estimate of the ice dynamic effect may be too low. Total sea level rise of as much as 6 m over the next century has been proposed based on a comparison with sea level rise rates at the end of the last ice age.

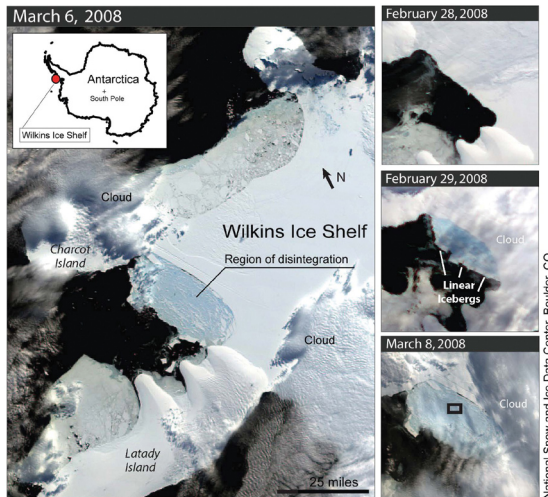
However, at the end of last ice age there was three times as much ice to melt as there is presently on the Earth. A rise of sea level by 6 m over the next century is improbable within constraints of the area of present day ice sheets, and the rate at which glaciers can accelerate.

A more generally accepted upper bound of sea level rise over the next century is 2 m. The probable rise will be less than this, although possibly toward the upper end of the IPCC AR4 estimate of around 0.8 m.



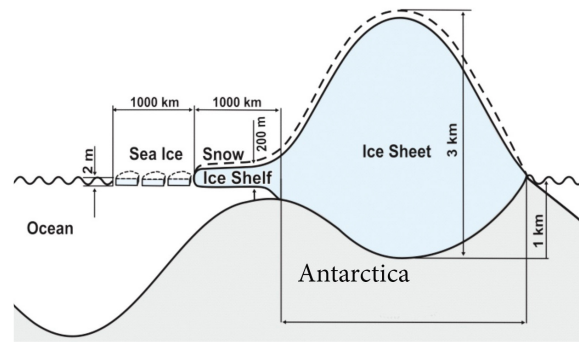
What is happening to ice shelves – and do they contribute to sea level rise?

A number of floating ice shelves along the Antarctic Peninsula have disintegrated dramatically over the last decade. The cause of their catastrophic collapse is a combination of melting at the base, which thins and makes them more vulnerable, and warmer summer temperatures which cause increased surface melt that can lead to rapid disintegration. Large areas of ice shelves (thousands of square kilometres of ice that is 100 to 200 m thick) have broken into small pieces and disintegrated within a few weeks.



MODIS satellite image of Wilkins Ice Shelf break up.
Image: NASA MODIS

The most recent example of this is the Wilkins Ice Shelf. The Wilkins Ice Shelf has undergone significant changes since 2008 after two significant break-up events in February and May 2008 and further losses in June and July 2008. These changes have been attributed to strong regional warming, and melting of the ice shelves from below.



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.

Loss of ice shelves does not contribute to sea level rise as they are already floating. But where ice shelves buttress glaciers flowing into the sea, accelerated glacier flow, due to loss of the ice shelf, can add to sea level rise. This is not the case for Wilkins Ice Shelf, but did occur when the Larsen B Ice Shelf dramatically collapsed.

What are the gaps in our knowledge that restrict better estimates of future sea level rise?

The main gaps in our understanding are of some aspects of ice sheet dynamics. There is a need to improve our mathematical models of ice streams, ice sheets and ice shelves to be able to better project future changes. We also need more detailed measurements of how deep the bedrock is under the ice sheets, to use in the models.

Another major gap concerns what is happening at the bed of the ice sheets – how they react with liquid water at the base, what role water may have in sliding processes, and the role of gravels and slurry at the base. We now know there is a lot of liquid water under the ice sheets, but we don't really know how changes in this may affect the ice flow.

[See our related fact sheet on ice sheets for further information.](#)

