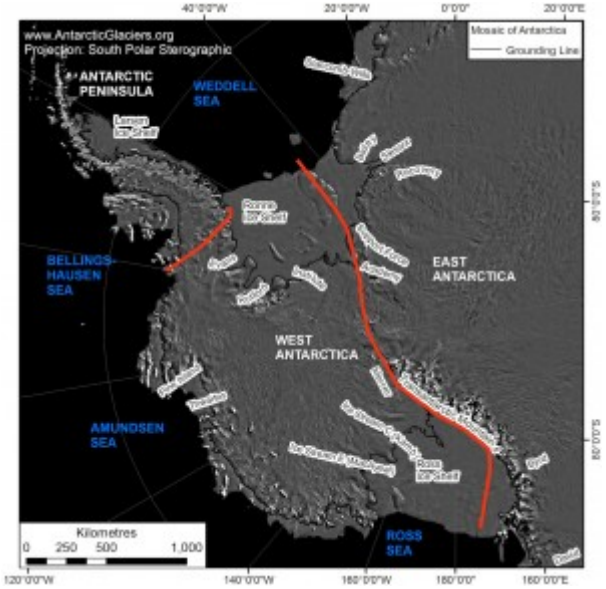
West Antarctic Ice Sheet

Introduction

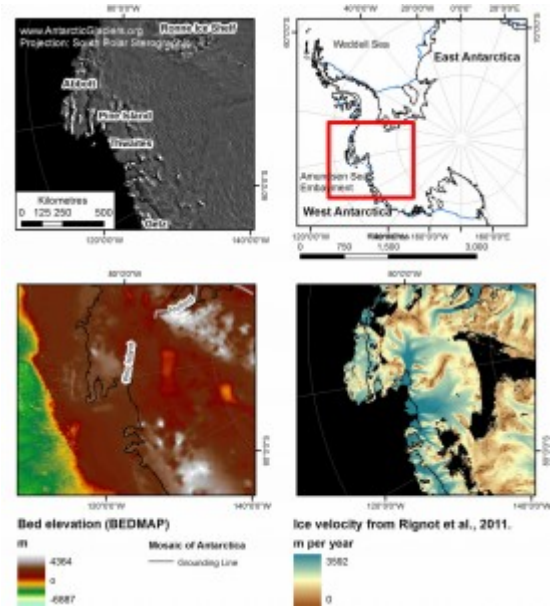


Landsat Image Mosaic of Antarctica, showing the different ice sheets of Antarctica

The West Antarctic Ice Sheet (the WAIS) is capable of rapid change as it is a marine ice sheet and therefore could be unstable. It has the potential to raise global sea level by 3.3 m[1] over a matter of centuries. The Transantarctic Mountains divide the West Antarctic Ice Sheet from the East Antarctic Ice Sheet[2]. West Antarctica is approximately 97% ice-covered, and is 1.97 x 10^6 km^2 in area. The West Antarctic Ice Sheet flows into the Bellingshausen, Weddell, Amundsen and Ross seas.

There are principally three sectors of the ice sheet, which flow northeast-ward into the Weddell Sea, westward into the Ross Ice Shelf and northward into the Amundsen/Bellingshausen seas. The highest elevations reached are 3000 m above sea level[2], occurring at the divides between these sectors. The size of the West Antarctic Ice Sheet is limited, despite its high average snow falls, by the faster speeds of its ice streams.

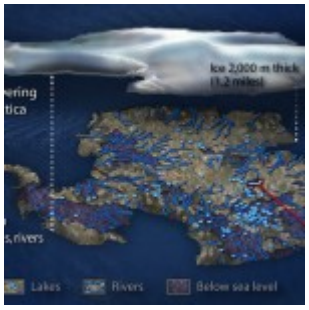
Topography



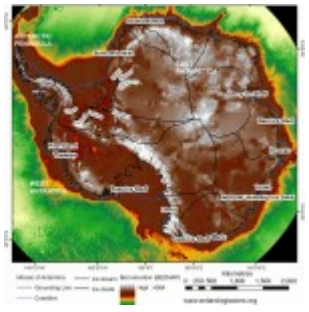
Images of the Amundsen Sea Embayment, showing: Landsat image (LIMA); BEDMAP bed elevation (from Lythe et al., 2001); and ice velocity (from Rignot et al. 2011)

The West Antarctic Ice Sheet is, in places, over 2000 m thick, with the geological floor well below sea level. The marine basins are variable, with both rough mountainous terrain and flat, deep oceanic basins[2], with a maximum depth of 2555 m below present sea level.

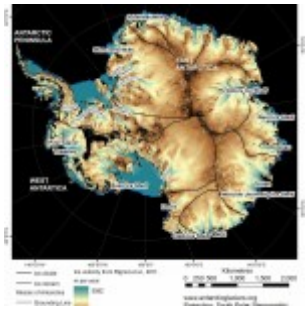
During past interglacials, the West Antarctic Ice Sheet has been completely removed[3], which is one of the arguments supporting a Marine Ice Sheet Instability hypothesis. During past glacials, the West Antarctic Ice Sheet extended to the continental shelf edge[4-6], drained by numerous ice streams[7, 8], such as the Pine Island and Thwaites ice streams, which flow out into the Amundsen Sea. In the four-panel figure opposite, you can see these two ice streams clearly. They are grounded below sea level and drain a large proportion of the West Antarctic Ice Sheet.



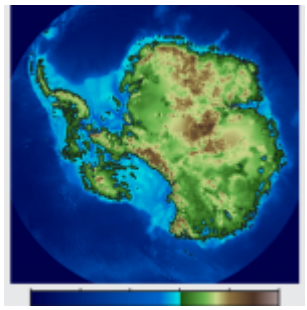
Subglacial lakes around Antarctica



BEDMAP: The bedrock topography of the Antarctic Ice Sheet

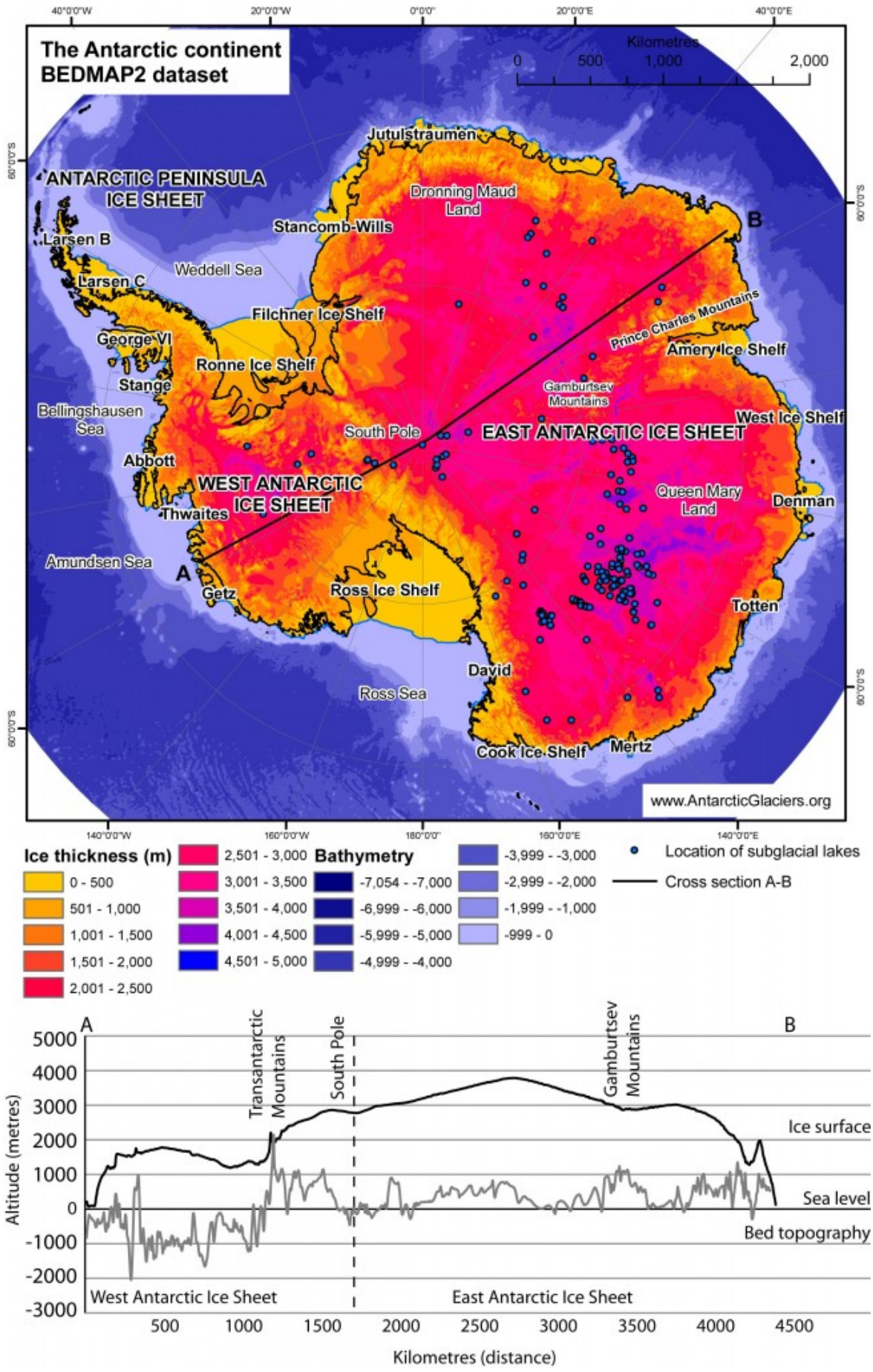


Velocity of the Antarctic Ice Sheet, showing the ice divides.



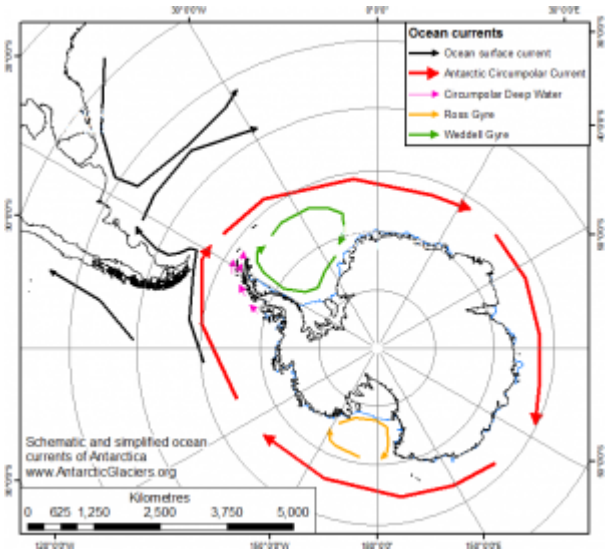
Isostatically corrected Antarctic continent with the ice removed. Global Warming Art Project.

In the map below, showing ice thicknesses across the Antarctic continent, you can see that the West Antarctic Ice Sheet has ice thicknesses of up to 2000 m, but that it is largely grounded below sea level. The maximum altitude of the ice surface is less than 2000 m above sea level. The West Antarctic Ice Sheet is divided from the East Antarctic Ice Sheet by the large Transantarctic Mountains.



The BEDMAP 2 dataset (Fretwell et al. 2013) shows how ice thickness across the Antarctic continent is variable, with thin ice over the mountains and thick ice over East Antarctica. The cross section shows how the West Antarctic Ice Sheet is grounded below sea level.

Oceanography

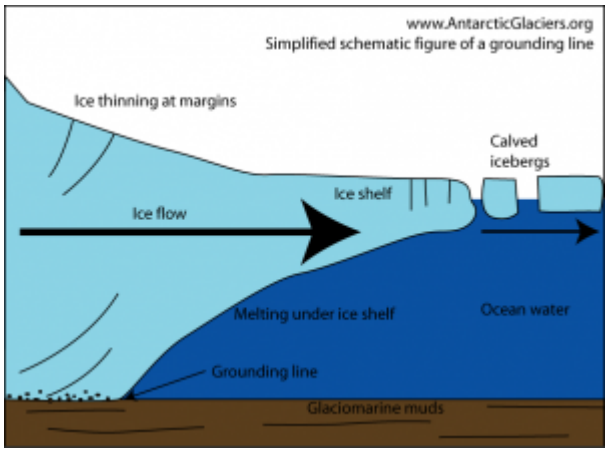


Simplified schematic map of ocean currents of the Southern Ocean.

West Antarctica is surrounded by a strong clockwise circumpolar circulation. These currents play a significant role in the global thermohaline circulation, and are one of the reasons why Antarctica is so cold.

At shallower depths, Circumpolar Deep Water can move across the continental shelf and reach the underside of ice shelves[2], which it can rapidly melt due to its relatively warm temperatures.

Ice streams and ice shelves



Simplified cartoon of a tributary glacier feeding into an ice shelf, showing the grounding line (where the glacier begins to float).

The West Antarctic Ice Sheet is drained by several large ice streams. The basal sediments of West Antarctica comprise soft marine sediments. Combined with geothermal heating at the base, this is sufficient to allow glaciers to slide rapidly: see Glacial Processes. This ice flow is partly constrained by buttressing ice shelves. The ice streams flow from an inland reservoir of ice towards the ocean, passing over a *grounding line* and, in places, into an ice shelf. Nearly all the precipitation received in West Antarctica eventually passes through these ice streams[2].

Further reading

To learn more about the West Antarctic Ice Sheet, you can read:

- Ice Shelves
- Ice Streams
- Marine Ice Sheet Instability
- Antarctica's contribution to global sea level rise
- Van den Broeke et al., 2011

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References

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