

Accelerating breakup of Thwaites Glacier in Antarctica and implications for rapid sea level rise

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Introduction

The Thwaites and Pine Island glaciers in Antarctica are flowing toward the Amundsen Sea along a 250 km wide front. Further inland, the glaciers widen into a 3 km thick mass of ice, the West Antarctica Ice Sheet, covering an area three times the size of Britain. The base of this ice sheet lies below sea level, at risk of being undermined by warming ocean waters, and the glaciers fringing it are rapidly retreating. In Briefing Note 357, we described the concern that the glaciers are going into irreversible retreat, meaning that no amount of climate change reversal could stop them from melting into the ocean. If both of these glaciers were to melt completely, they would raise the sea level of the world's oceans by 1 metre. What is worse, together these glaciers act as a plug holding back enough ice to raise the sea level of the world's oceans by over 3 metres—an amount that would submerge large areas of the world's coastal cities. New information released in December (Pettit et al., 2021) indicates that breakup of these glaciers is accelerating, with the potential to accelerate sea level rise.

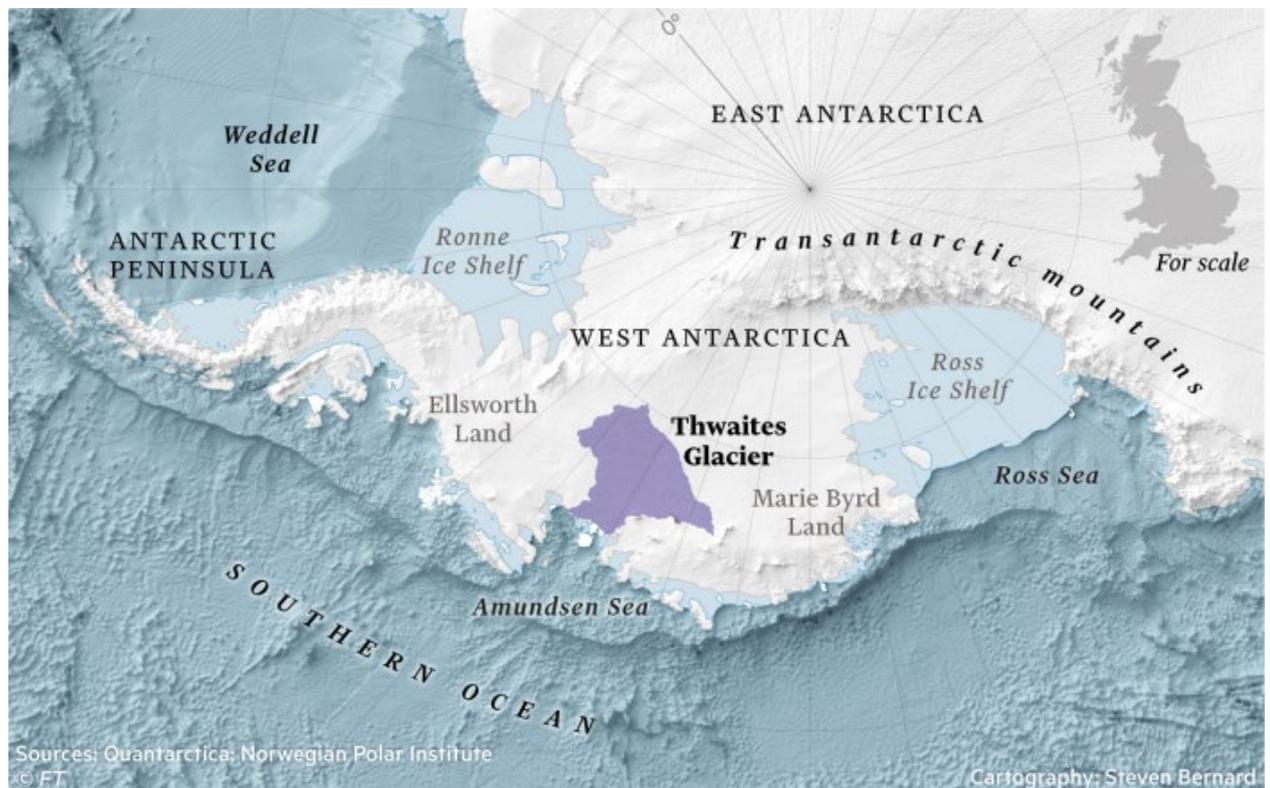


Figure 1. Location of the Thwaites Glacier, which forms a plug between the West Antarctica Ice Sheet and the Amundsen Sea. Sources: Quantarctica; Norwegian Polar Institute.

Twenty years ago, an area of ice thought to weigh almost 500bn tonnes dramatically broke off the Antarctic continent and shattered into thousands of icebergs into the Weddell Sea. The 1,255-sq-mile (3,250-sq-km) Larsen B ice shelf was known to be melting quickly but no one had predicted that it would

take just one month for the 200-metre-thick block of ice to completely disintegrate. Glaciologists were shocked as much by the speed as by the scale of the collapse.

The Thwaites Glacier is about 100 times larger than Larsen B ice shelf, about the size of Britain, as shown in Figure 1, and contains enough water on its own to raise sea levels worldwide by more than half a metre. It contributes about 4% of annual global sea level rise. Satellite studies show that it is melting far faster than it did in the 1990s.

Evidence of Accelerating Disintegration of the Thwaites Eastern Ice Shelf

The Thwaites Eastern Ice Shelf is the floating terminus of the Thwaites Glacier, and is stabilized offshore by a marine shoal and acts as a dam to slow the flow of ice off the continent into the ocean. Since our 2018 Briefing Note was written, satellite radar imagery has shown many new fractures opening on this ice shelf, similar to the one in the Pine Island Glacier in Figure 2. Pettit et al. (2021) mapped out weaker and stronger areas of the Thwaites Eastern Ice Shelf and suggest a zig-zag pathway that fractures might take through the ice, ultimately leading to break up of the shelf in as little as 5 years, which would result in more ice flowing off the continent.

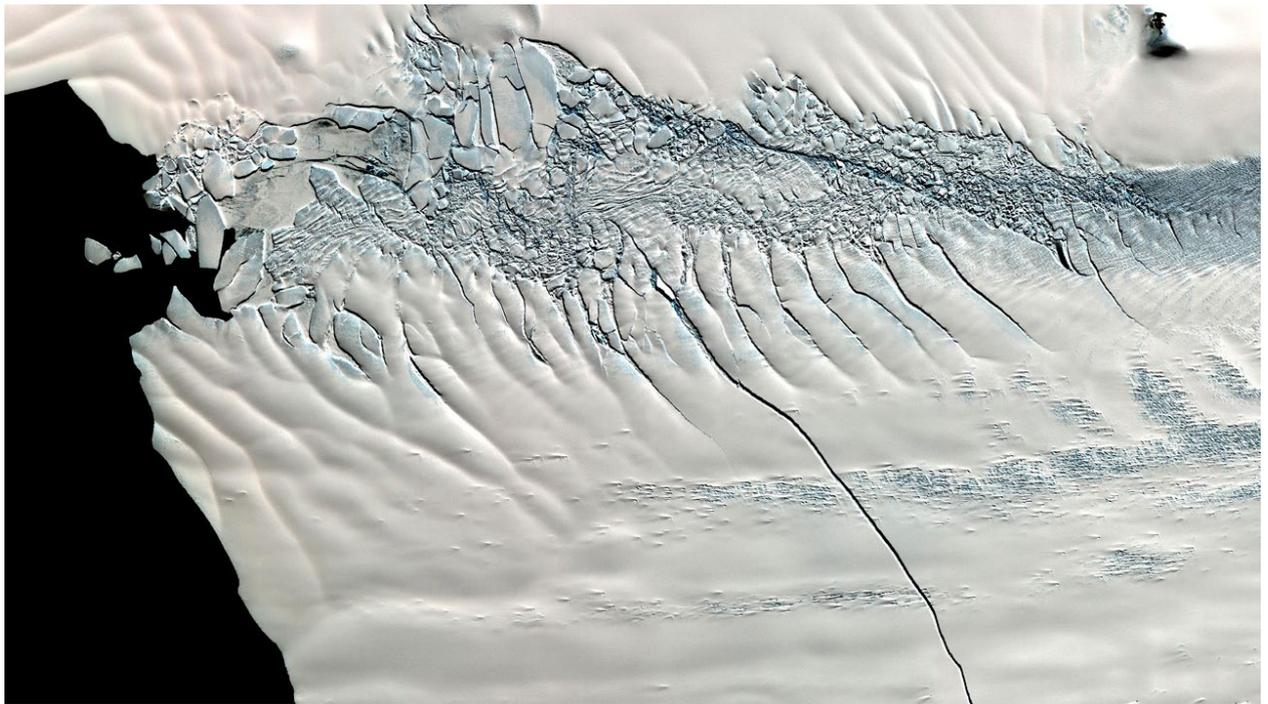


Figure 2. A 30-kilometer crack runs across the Pine Island Glacier, a vulnerable part of the West Antarctic Ice Sheet.
Source: NASA/GSFC/METI/ERSDAC/JAROS, AND U.S./JAPAN ASTER SCIENCE TEAM/FLICKR

The Thwaites Glacier is worrisome, but many other great glaciers in [Antarctica](#) are also retreating, thinning and melting as the Southern Ocean warms. Many are being held back because the Thwaites Glacier acts like a cork, blocking their exit to the sea. Should Thwaites disintegrate, scientists believe the others would speed up, leading to the collapse of the whole ice sheet and catastrophic global sea level rises of several metres.

Whether and how quickly they may collapse are some of the most important questions of the age. Sea levels are rising rapidly: the annual rate of increase more than [doubled from 1.4mm to 3.6mm between 2006 and 2015](#) and is rapidly accelerating. The consensus of glaciologists used to be that it would take

centuries of global warming before glaciers the size of Thwaites shattered and collapsed. However the loss of sea ice at the opposite end of the earth in the Arctic has been so rapid and unexpected, and [the loss of the Larsen B Ice Shelf](#) was so sudden, that it is now considered possible that it could happen rapidly in Antarctica too. The tipping point for the Larsen B ice shelf came suddenly, but it is not yet known how Thwaites and other glaciers will respond to global warming. Ice loss in the Arctic barely affects sea levels because it mostly forms at sea. Antarctic ice, however, is mostly on land so any melting adds to sea levels.

Has the West Antarctic Ice Sheet Disintegrated Before?

During the last brief warm period (the Eemian) between ice ages 125,000 years ago, when temperatures were barely higher than they are today, sea levels were 6 to 9 metres higher than they are now, drowning large swathes of coastline. Using sediment cores from Antarctica, scientists recently identified the source of all that water: a collapse of the West Antarctic Ice Sheet. This demonstrates that the ice sheet disappeared in the recent geological past under climate conditions similar to those today. This suggests that the West Antarctic Ice Sheet might not need a huge nudge to begin moving, and that the large increase in mass loss observed there in the past decade or two is perhaps the start of that process rather than a short-term event. If so, the world may need to prepare for the sea level to rise farther and faster than expected: Once the ancient ice sheet collapse got going, some records suggest that sea level rose as fast as 2.5 meters per century.

It is unfortunate that this information about the instability of the Thwaites Glacier came to light one month after Cop26 ended in Glasgow in November, as governments become preoccupied again by Covid-19 and the return of normal politics. Pettit et al. (2021) are concerned that the Thwaites Eastern Ice Shelf may break up in as little as 5 years, which would result in an acceleration of ice flowing off the continent and accelerating sea level rise. The many actions pledged in November to address global warming may be even more necessary than was thought just a month ago.

References

Pettit, Erin et al. (2021). C34A-07 - Collapse of Thwaites Eastern Ice Shelf by intersecting fractures <https://agu.confex.com/agu/fm21/meetingapp.cgi/Paper/978762>

Risk Frontiers (2018). Thwaites and Pine Island Glaciers of Antarctica and the Prospect of Rapid Sea Level Rise. [Briefing Note 367, May 2018](#).