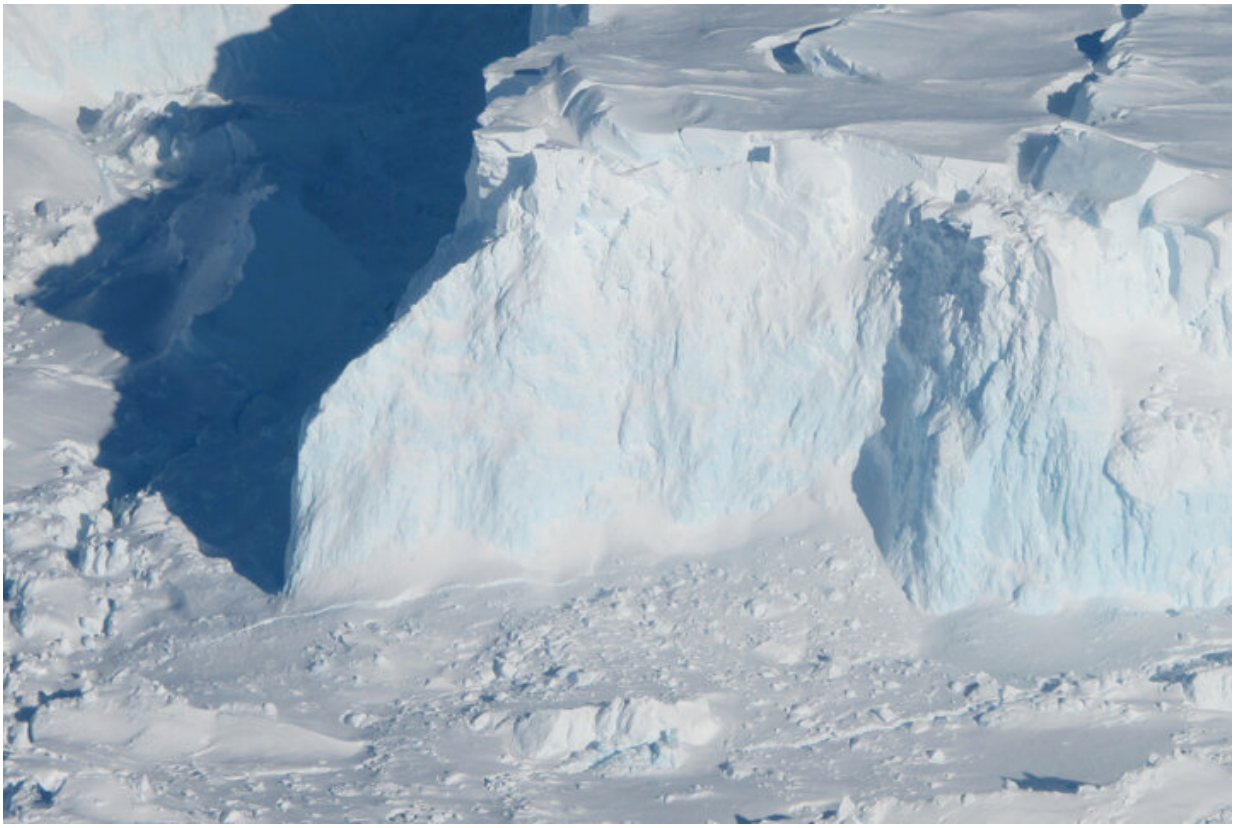
New study models impact of calving on retreat of Thwaites Glacier

December 5 2019, by Sara Edwards



An edge of Thwaites Glacier captured by NASA's Operation IceBridge in 2012. Credit: NASA/Jim Yungel

The loss of the ice shelf supporting one of Antarctica's most vulnerable glaciers could hasten its collapse, a new study finds.

Thwaites Glacier, a sheet of ice about the size of Florida, lies in West Antarctica. Scientists have monitored this region for decades because it contributes about a tenth of current global sea level rise, according to a 2017 study. Researchers attribute the thinning glaciers in this region to warming ocean water in the Amundsen Sea, which intrudes under the glaciers and melts them from beneath.

The new study in the AGU journal *Geophysical Research Letters* modeled how much faster Thwaites, one of the region's largest and fastest-retreating glaciers, would retreat in the absence of its ice shelf —the part of the glacier that floats on top of the sea, supporting the thicker ice behind.

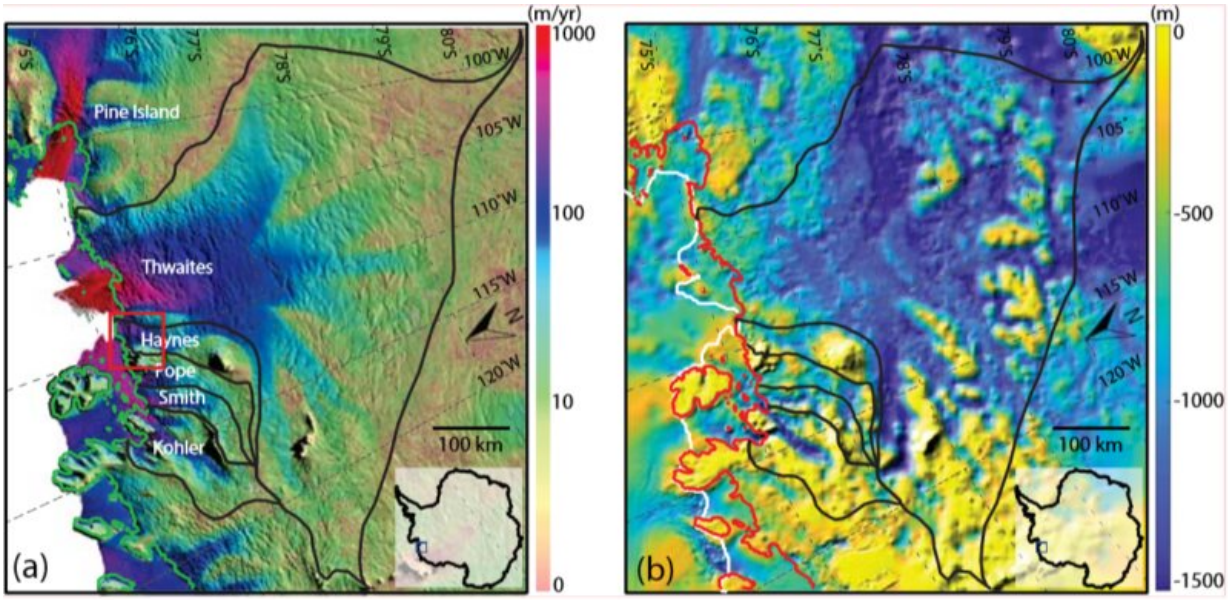
"We think that possibly in a few years or decades, we don't know yet, the remainder of the ice shelf in front of Thwaites might be gone," explained Hongju Yu, an assistant specialist at the University of California, Irvine and lead author of the new study.

If the ice shelf disappeared, it would no longer provide resistance to the glacier's flow, allowing the glacier to accelerate. The glacier would then begin losing mass mainly through increasing breakup of chunks of ice at its leading edge—a process called calving. The aim of the new study was to simulate how much Thwaites' retreat would accelerate through calving once the ice shelf disappears.

The researchers ran 20 different simulations combining the effects of two different calving mechanisms and ice front melting—melting that is concentrated at the glacier's edge rather than distributed over the entire ice shelf. Depending on the scenario, they found the volume of ice lost would increase between 5 percent and 160 percent compared to estimates based on ice shelf melt alone.

In the worst-case scenario, Thwaites could completely collapse within 60

to 70 years, according to the study's authors. Other scenarios predict the glacier to remain stable for an additional century. In each scenario, once Thwaites Glacier retreats past the ridge that anchors it to land, the retreat becomes unstoppable.



Satellite imagery and radar soundings show ice speeds (a) and bed elevation above sea level (b) in West Antarctica. Thwaites Glacier is shown in the center. The green line in a) and the red line in b) show the grounding line positions in 2011. Credit: AGU

If Thwaites collapsed, it could raise global sea level by more than half a meter (nearly two feet) and lead to a domino effect of further glacier collapse in West Antarctica.

"Worst-case scenario, it is going to be gone in less than a century," Yu said. "But it may also take much longer."

The point of no return

Part of what makes Thwaites Glacier so vulnerable is its unique shape and position, according to the study's authors.

Today, the part of Thwaites that floats on top of the ocean—its ice shelf—acts as a buttress, keeping the taller ice behind from collapsing under its own weight and shielding it from warming sea water. Underneath the front of the ice, the glacier extends a few kilometers to the point where it clings to a ridge of solid rock—the glacier's grounding line. This is what anchors Thwaites in place.

Beyond this line, the glacier sits atop a deep basin that lies below sea level and slopes downwards inland—a configuration glaciologists consider unstable. Once seawater overtakes the grounding ridge and floods into this basin, it can begin to eat away at even more ice beneath.

Past research has suggested that more ridges, like mountains under the ice, could slow Thwaites' retreat. But the results of the new study suggest that once Thwaites' grounding line retreats past a particular ridge—called the western subglacial ridge—the glacier's collapse is inevitable.

At present, Thwaites' grounding line is only 30 kilometers from the western ridge, migrating towards it at more than 1 kilometer per year. This means the grounding line will reach the critical point of no return within the next 30 years, according to the study's authors.

"If you go past the ridge, then it's always in an unstable configuration," Yu said. "Even if you stop the ocean warming, the glacier will continue to retreat and lose mass rapidly."

The enormous range of the speed of retreat is what makes predicting

Thwaites' lifespan so uncertain, and why it is critical to study the effects of calving on glacier retreat, according to the study's authors. The new study provides scientists with estimates of the rate of retreat with calving, which had been partially missing from previous research over the time period of 100 years.

If Thwaites Glacier's grounding line stabilizes on the western subglacial ridge, Yu said, global sea level will rise by 13-19 millimeters. But if it collapses, it will raise global sea levels by 50 millimeters within the century.

"The rapid collapse is a worst case, but we did not know until this study that it could happen as soon as the next 60-70 years," Yu said. "If the glacier does not collapse within these next 60-70 years, it will continue losing mass for centuries, just not as rapidly."

More information: Hongju Yu et al. Impact of iceberg calving on the retreat of Thwaites Glacier, West Antarctica over the next century with different calving laws and ocean thermal forcing, *Geophysical Research Letters* (2019). DOI: 10.1029/2019GL084066

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