Damage uncovered on Antarctic glaciers reveals worrying signs for sea level rise

October 2 2020, by Lily Roberts

Crevasses observed on Pine Island Glacier. These open fractures are a sign of structural weakening. Credit NASA

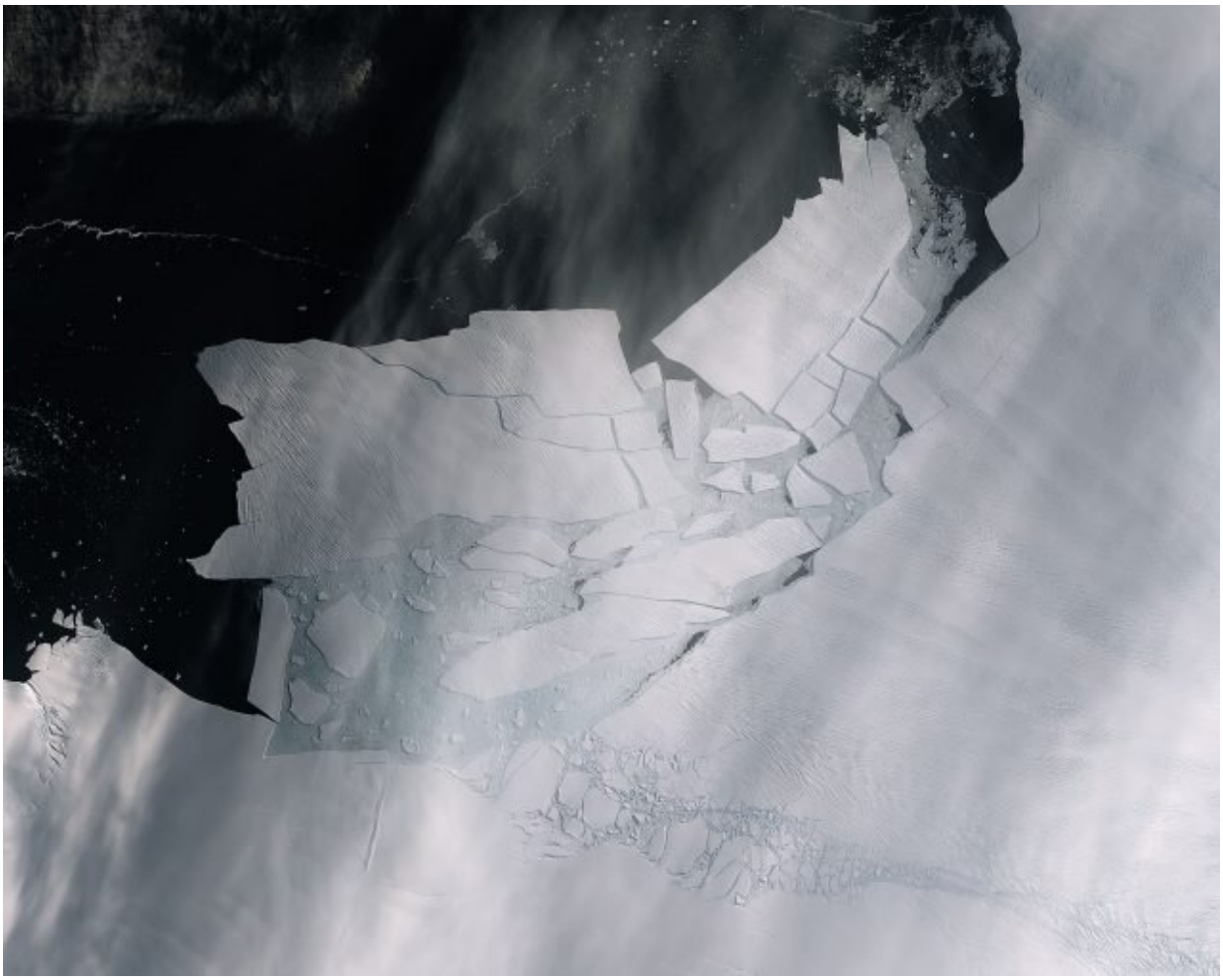
A new study into the structural damage of two major Antarctic glaciers reveals that ice shelf weakening has rapidly evolved in recent years.

Multi-satellite imagery identified damage areas, sparking concerns that structural weakening could lead to major ice shelf collapse in the decades to come. This collapse, in turn, reduces the glaciers' ability to hold back major sections of the entire West Antarctic Ice Sheet from running into the ocean.

Pine Island Glacier and Thwaites Glacier are located in the Amundsen Sea Embayment. The fastest-changing outlet glaciers in the region, they account for Antarctica's largest contribution to global sea level rise. Scientists have anticipated for at least 20 years that these glaciers will be the first to respond to climate change, Jessica O'Reilly, an environmental anthropologist at Indiana University, told GlacierHub.

If the ice shelves of these two glaciers collapse, it could trigger large-scale disintegration of the nearby West Antarctic Ice Sheet, which holds enough ice to raise global sea level by about 10 feet. The glaciers provide a natural buffering system that is holding back the enormous ice sheet upstream, but if structural damage is weakening the ice shelves, rapid outflow into the ocean could occur in the coming years.

The study results reveal that since 2016, damage in the shear zone of Pine Island and Thwaites glaciers has rapidly developed. The shear zone is located where the glacier meets the ice shelf, which acts as a braking system that slows the downstream flow of the glaciers towards the sea. Due to the resistive forces and stresses, ice breaks in this zone where the two meet, as seen in the image above. Parallel crevasses have formed perpendicular to the direction of flow, tearing apart the ice. Satellite imagery shows that for Pine Island, the south shear zone has been torn apart and fragmented, and for Thwaites, damage is accelerating upstream in its shear zone.



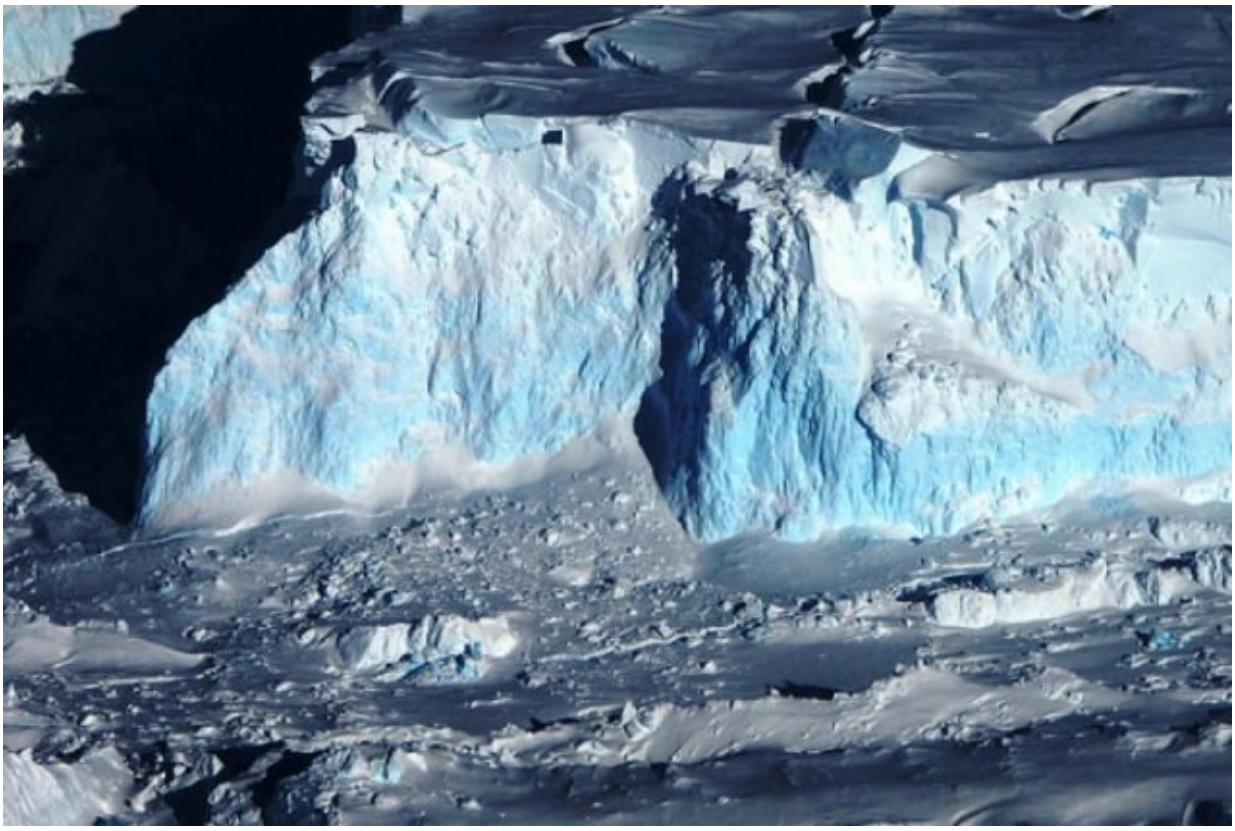
A large calving event on Pine Island Glacier's ice shelf in February 2020, observed from the Corpernicus satellite. Events like these may become all too common in the future, as fracturing and weakening of the ice increases. Credit: European Space Agency

Fracturing in the shear zone structurally weakens the ice front. At the same time, the glaciers have been increasing in downslope velocity, which in turn initiates further shearing and fracturing. This is rendering the ice shelves unstable, paving the way for large calving events while also reducing the shelf's ability to hold back the outflowing glacier.

In February 2020, a large rift developed across Pine Island's shelf due to damage in the shear zone. Satellites observed a huge calving event that caused unprecedented retreat of the ice shelf, further destabilizing it.

Adding to the concerns for these glaciers, warmer ocean waters in the Amundsen Sea is melting the ice shelf from below. Changing atmospheric and oceanic patterns are sweeping warm deep waters towards the floating ice shelves of Pine Island and Thwaites glaciers. Melting from below is making the overlying ice shelf even more brittle and thus susceptible to further shearing and fracturing. Study co-author Bert Wouters told GlacierHub that without ocean warming, we would not be seeing the changes and processes we are observing.

Furthermore, these glaciers are sitting on reverse bed slopes. This means once the glaciers start retreating, they will retreat further and further in a positive feedback loop. "At some point we may reach a point of no return, where collapse will be unstoppable. Once you remove the ice shelves, there is no way of stopping the mass loss of Antarctica," Wouters told GlacierHub.



Thwaites Glacier. Clearly seen are open fractures and a calving front. Although these have been long recognized, scientists are looking to see whether recent changes to the ice front is a distinctive signature of climate change. Credit: NASA/James Yungel

A significant challenge across climate science is to distinguish natural ice behavior from variability caused by human influence, confirms O'Reilly. However, the rapid changes to Pine Island and Thwaites Glaciers have been clearly connected to anthropogenic climate change. O'Reilly, who has been following the study of Antarctic glaciology since 2008, tells that great progress has been made in understanding these glaciers. "Teams of scientists have been puzzling over these glaciers since the middle of the last century. This puzzling means a lot of exciting, innovative approaches to learning about the glaciers has emerged."

Although satellite images have long been used as a tool for studying these glaciers, the significance of this study is that the damage now observed is setting up further, and potentially catastrophic, ice loss in Antarctica. These glaciers are the gateway to the continent, and therefore rapidly developing damage to the barrier that is stopping the ice sheet from sliding into the ocean is a critical concern for scientists. But they're not the only ones who should be worried. O'Reilly reminds us that these changes will affect coastal communities, livelihoods and ecosystems globally.

Despite the significance of the new results, Wouters warns that there are still a lot of unknowns. "We keep finding new processes and feedbacks, so there might be others that we are not aware of yet, and those that we know about we don't fully understand yet, nor are these feedbacks incorporated into models."

Pine Island and Thwaites glaciers are endangered, and the current damage is almost impossible to heal. "These are the two key glaciers in West Antarctica that will define global sea level over the coming decades," Wouters told GlacierHub. Although major ice shelf collapse is unlikely to occur in the coming years, we are seeing the processes speed up, so it might be a matter of decades, explained Wouters. If the new predictions for further destabilization and ice loss prove to be accurate, the implications for sea level rise are likely to be severe.

This story is republished courtesy of Earth Institute, Columbia University http://blogs.ei.columbia.edu.

Provided by Earth Institute at Columbia University