

Coastal glacier retreat linked to climate change

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Eqip Sermia, like many coastal glaciers in Greenland, has retreated in the last two decades. Credit: John Erich Christian/University of Texas Institute for Geophysics/Georgia Tech

More of the world's coastal glaciers are melting faster than ever, but

exactly what's triggering the large-scale retreat has been difficult to pin down because of natural fluctuations in the glaciers' surroundings. Now, researchers at the University of Texas Institute for Geophysics (UTIG) and Georgia Tech have developed a methodology that they think cracks the code to why coastal glaciers are retreating, and in turn, how much can be attributed to human-caused climate change. Attributing the human role for coastal glaciers—which melt directly into the sea—could pave the way to better predictions about sea level rise.

So far, scientists have tested the approach only in computer models using simplified glaciers. They found that even modest global warming caused most glaciers to melt, or retreat.

The next step, the researchers said, is for scientists to simulate the coastal glaciers of a real ice sheet, like Greenland's, which holds enough ice to raise sea level by about 22 feet (7 meters). That will reveal whether they are retreating due to climate change and help predict when major ice loss might next occur.

"The [methodology](#) we're proposing is a road map towards making confident statements about what the human role is [in glacial retreats]," said glaciologist John Christian, who is a postdoctoral researcher at both The University of Texas at Austin and Georgia Tech. "Those statements can then be communicated to the public and policymakers, and help in their decision making."

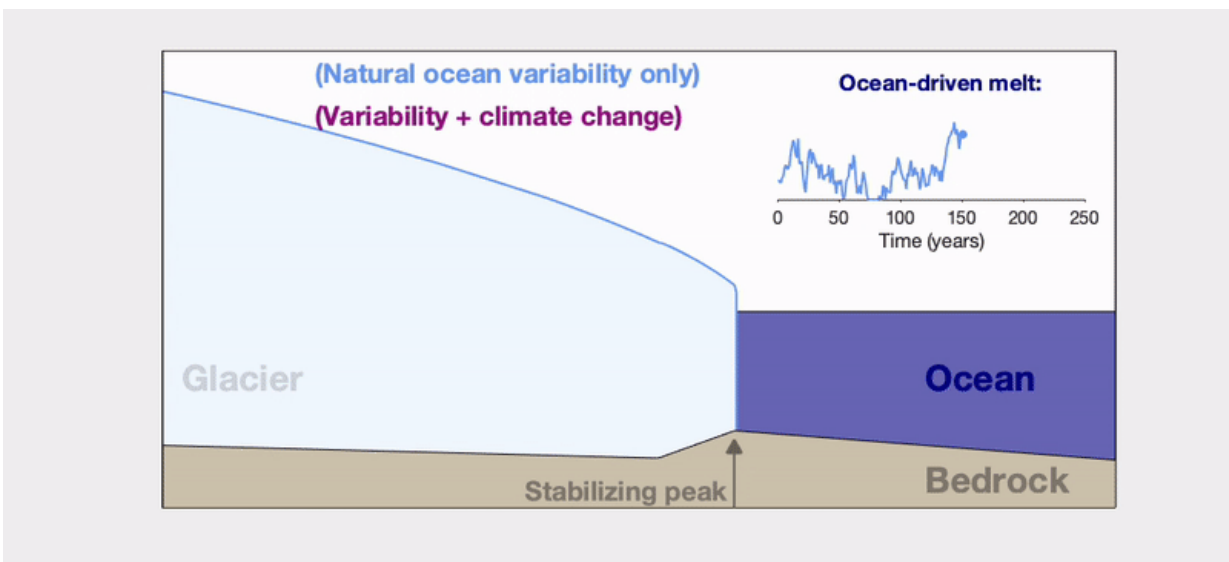
Published in the journal *The Cryosphere*, the methodology is unique because it treats rapid glacier retreat as an individual probabilistic event, like a wildfire or tropical storm. For a large retreat to happen, the glacier must retreat past its "stability threshold," which is usually a steep rise in the underlying bedrock that helps slow its flow. The probability of that happening varies depending on [local climate](#) and ocean conditions that change with natural fluctuations and human-caused warming. Even small

variations can cause large changes in a glacier's behavior, making them hard to predict and leading to cases where glaciers were found retreating right next to ones that weren't.

That, said co-author and UTIG glaciologist Ginny Catania, is why the last Intergovernmental Panel on Climate Change report found there was still too much uncertainty about coastal glaciers to say whether their retreat is due to human-caused climate change or natural climate fluctuations.

The new study shows how to overcome the uncertainty by providing a methodology that accounts for differences between glaciers and natural climate fluctuations, while testing the effect of background trends such as global warming. According to Catania, the study means they can now attribute mass coastal glacier retreat to [climate](#) change and not just natural variability.

"And that's the first time anyone's done that," she said.



Overlapping simulations of a glacier, one with climate change and the other without. Glaciers melt dramatically when they retreat past their stabilizing threshold, shown here as a peak in the bedrock. According to research from the University of Texas Institute for Geophysics and Georgia Tech, that becomes much likelier with climate change. Credit: John Erich Christian/University of Texas Institute for Geophysics/Georgia Tech

To test the methodology, the team ran thousands of simulations of the past 150 years with and without global warming. The simulations showed that even modest warming dramatically increased the probability of ice sheet-wide glacier retreat.

When the scientists ran models without human-caused [climate change](#), they found it virtually impossible for more than a few of the glaciers to begin retreating within years of each other.

By contrast, since 2000, nearly all (200) of Greenland's 225 coastal glaciers have been in varying states of retreat.

"This study gives us a toolbox to determine the role of humans in the loss of ice from Greenland and Antarctica, to say with confidence that it's not just coincidence," said Georgia Tech glaciologist and co-author Alex Robel.

More information: John Erich Christian et al, A probabilistic framework for quantifying the role of anthropogenic climate change in marine-terminating glacier retreats, *The Cryosphere* (2022). [DOI: 10.5194/tc-16-2725-2022](#)

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