Powerful 'rivers in the sky' could cause Antarctic Peninsula's biggest ice shelf to collapse

By Angela Dewan, CNN

Updated 1459 GMT (2259 HKT) April 14, 2022

The Larsen C ice shelf on October 31, 2017, after a massive iceberg calved from it.

(CNN) When temperatures in Antarctica soared to 38 degrees Celsius above normal -- around 70 Fahrenheit -- in March, a teetering ice shelf the size of Los Angeles collapsed. Scientists don't know what role the extreme temperatures may have played in the event, but the heat rushed in through what's known as an atmospheric river, a long plume of

moisture that transports warm air and water vapor from the tropics to other parts of the Earth.

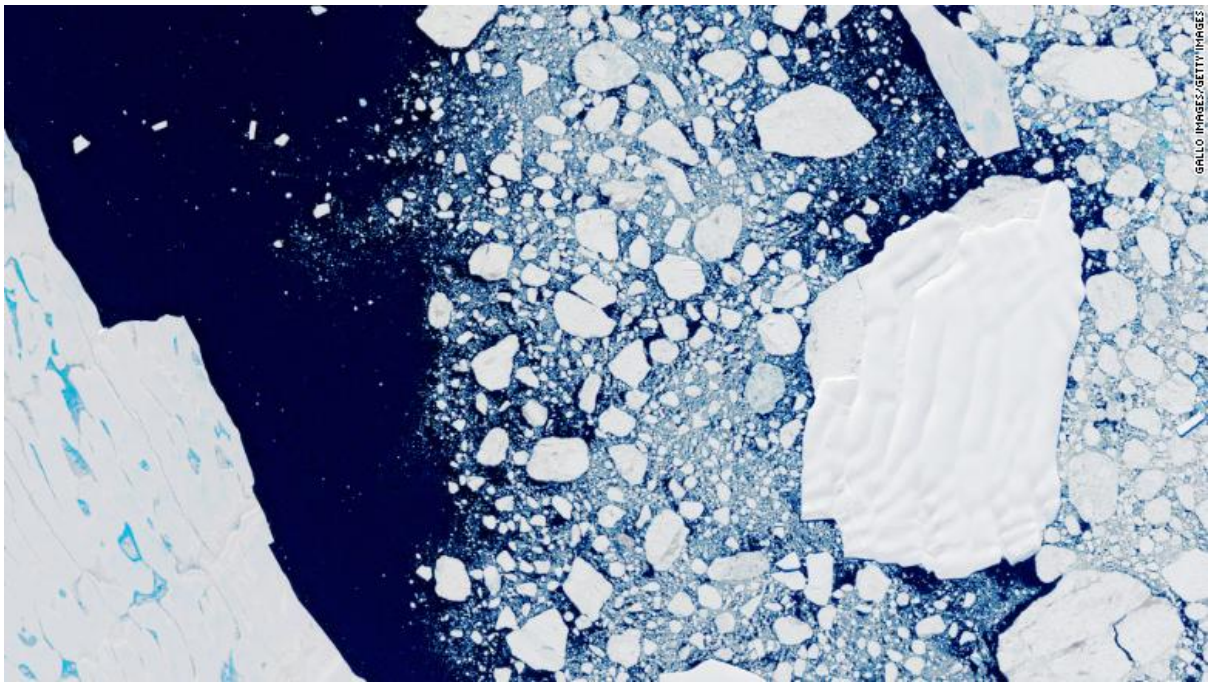
A new study published Thursday shows that these "rivers in the sky" -- which dump rain and snow when they make landfall -- are also causing extreme temperatures, surface melt, sea-ice disintegration and large ocean swells which are destabilizing ice shelves on the Antarctic Peninsula, a long, spindly mountain chain that points northwards to the tip of South America.

These conditions were observed during the collapse of two of the peninsula's ice shelves -- Larsen A and B -- in the summers of 1995 and 2002, respectively. And now, as the climate crisis is projected to warm the Earth further, the biggest remaining ice shelf, Larsen C, is also at risk of total collapse, the study says.

-

The authors of the study, published in the Nature journal Communications Earth & Environment, used algorithms, climate models and satellite observations to determine that 60% of the peninsula's calving events -- where an iceberg breaks off an ice shelf or glacier -- were triggered by atmospheric rivers between 2000 and 2020.

-



An image of the Larsen B ice shelf on the Antarctic Peninsula in 2000, before its collapse in 2002.

There are many ways these ice shelves can destabilize. For Larsen A, B and C, there has been evidence of foehn winds -- warm, dry air that streams down a mountain after cool, moist air had risen up the other side. These can cause sudden and dramatic changes in temperatures, and in Antarctica, it causes ice melt. That can have knock-on effects, including fracturing in ice shelves -- the portion of a land-based ice sheet that juts out over ocean water.

Melting sea ice also exposes ice shelves to ocean swell, which can cause further destabilization.

"What our study found was that all these different aspects are actually caused by atmospheric rivers, especially the intense ones," one of the study's lead authors, Jonathan Wille from the Université Grenoble Alpes in France, told CNN.

-

"And we found that almost all the really extreme temperature events that happen in the Antarctic Peninsula where happening with atmospheric rivers."

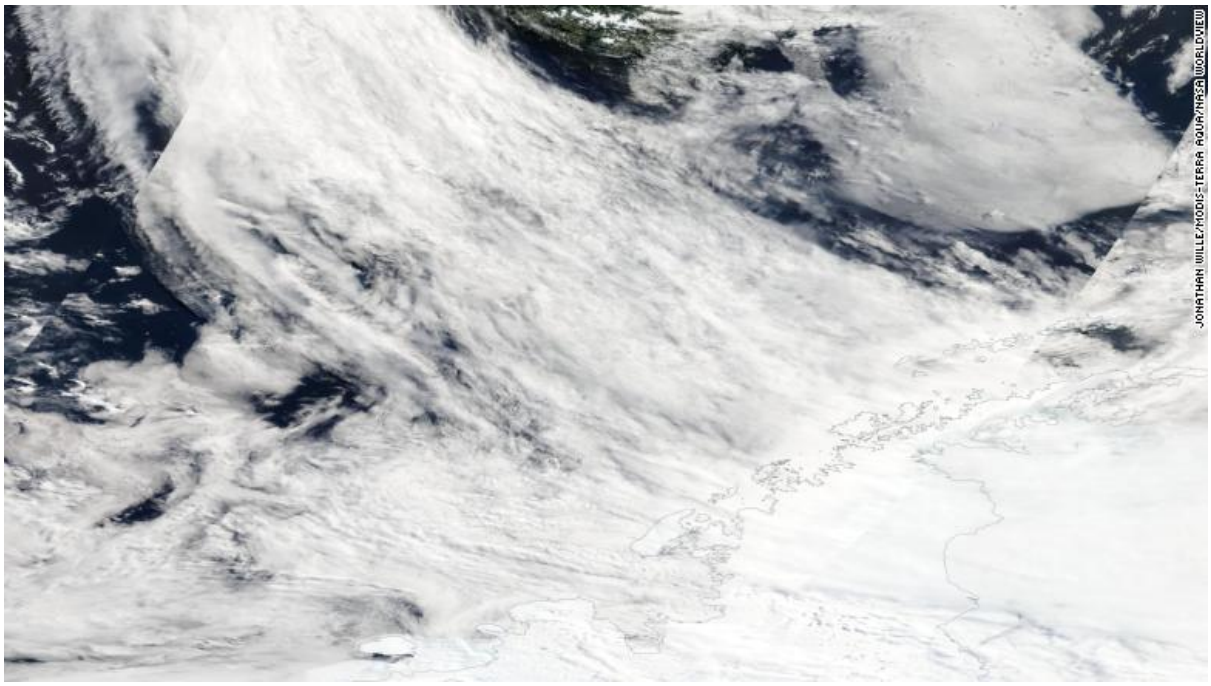
What it means for sea level

A collapse of Larsen C would spell bad news for the sea level around the planet.

Ice shelves breaking off and can cause sea level rise, but they don't add a huge volume -- that's because they are already floating in the water. But ice shelves play a critical role in preventing much larger sea level rise.

"Ice shelves keep the glaciers that are on land behind them from flowing into the ocean," Wille said. "And when these shelves disappear, there's nothing holding back those glaciers. Their velocity increases and starts flowing into the ocean. And that then directly contributes to sea level rise."

Scientists don't yet know what link there may be between atmospheric rivers and climate change, but the recent heatwave and conditions in Antarctica at the time were were so extreme that experts are starting to hypothesize the crisis could be playing a role. That will only really become clearer if a similar event happens again in the future.



Satellite imagery from an atmospheric river over Antarctica on January 25, 2008, which scientists say triggered the disintegration of ice in the Larsen A and Larsen B shelves.

"The question is whether or not atmospheric rivers will happen more often as the climate changes," Julienne Stroeve told CNN. Stroeve, who was not involved in Thursday's study, is a professor of polar observation and modeling at University College London.

"I think it's too soon to say it will," she said, adding that different atmospheric analyses were giving differing results. "However, it's likely that the atmosphere will play an increasing role in ice shelf breakup by weakening them through surface melting."

While the future frequency of atmospheric rivers may be an unknown, Wille believes they will at the very least become more intense, and that could be enough to cause more destabilization.

"It's kind of simple -- as the atmosphere becomes warmer, it's able to hold more moisture, and since an atmospheric river is essentially the transport of moisture, that means there will be more moisture that can be transported to Antarctica," he said.

John Turner, a meteorologist at the British Antarctic Survey who was also not involved in the study, said that most of an ice shelf's instability was due to basal melt -- that's melting that happens from the bottom -- and warned against placing too much emphasis on the role of atmospheric rivers. The study published in Nature did not find a link between atmospheric rivers and basal melt.

"You have to be careful -- you do get extremes for other reasons which don't have a river. Sometimes you just get strong northerlies, which will generally give you a lot of snow and high temperatures, which may not be classified as a river," he told CNN.

Turner agrees, however, that the wind that atmospheric rivers bring may be "the nail in the coffin of some of these ice shelves."

-

To put in perspective what a ice loss in Antarctica could mean for the world, Turner explained there are 60 meters -- nearly 200 feet -- of potential sea level rise if the whole continent's ice melted. Western Antarctica, the broader region around the peninsula, represents 6 meters (20 feet) of rise, which in itself would swallow entire islands and be catastrophic for millions of people living on coasts and beyond.

Most of the world's ice melt and sea level rise so far can be attributed to melting of the Greenland ice sheet in the Arctic.