Changing atmospheric conditions may contribute to stronger ocean waves in Antarctica

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The Ross Ice Shelf, the largest of its kind in Antarctica. Credit: Rob Anthony, USGS

Over the past few years, a large fracture has grown across a large floating ice shelf on the Antarctic Peninsula. The world is watching the ice shelf, now poised to break off an iceberg the size of Delaware into

the ocean.

It's not a new phenomenon; this "thumb" of Antarctica, which juts out into the stormy Southern Ocean, has lost more than 28,000 square kilometers of floating ice—almost as large as Massachusetts—over the past half-century. This has included the complete disintegration of four ice shelves, the floating extensions of glaciers.

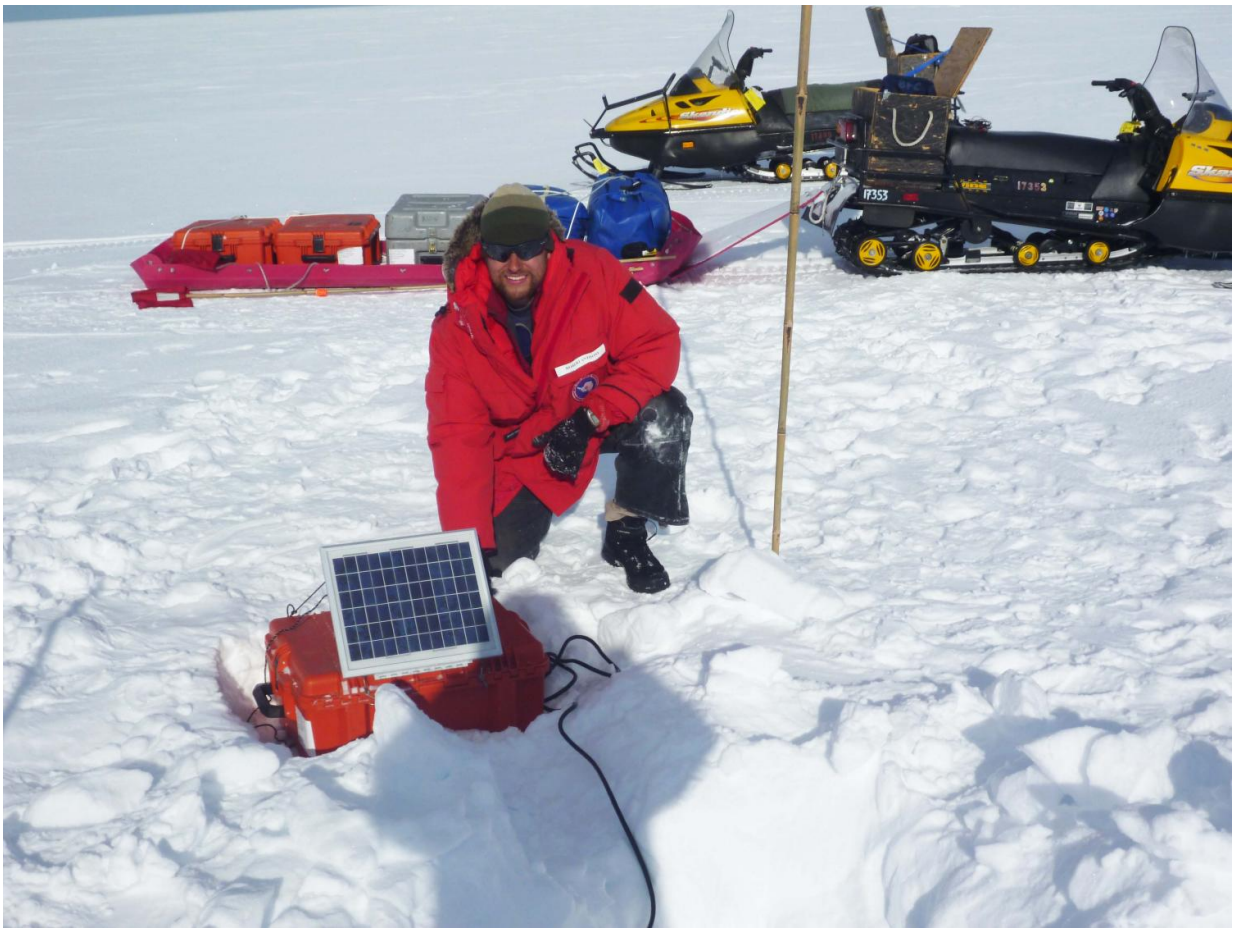
Now, a new study led by Colorado State University provides important details on the extent of sea ice, which can protect ice shelves from the impacts of ocean storms, in the Antarctic Peninsula.

El Nino-like weather patterns in Antarctica

Scientists have long thought that a shift in the Southern Annular Mode, which describes a large-scale pattern of atmospheric variability for the Southern Hemisphere similar to El Nino in the tropics, may produce conditions that can lead to the collapse of ice shelves.

The CSU-led research team offers important details on how the Southern Annular Mode affects storm activity and the extent of sea ice surrounding the Antarctic Peninsula. Sea ice may protect ice shelves from the impacts of ocean storms by weakening wave intensity before it reaches the coastline.

The researchers utilized a novel approach of studying long-term variations in seismic signals, called microseisms, generated by ocean waves in the region. The findings have implications for the wave environment of the Southern Ocean and, potentially, for factors driving the collapse of ice shelves, which can lead to an accelerated increase in global sea level.



CSU researchers, including Rob Anthony (pictured), measured seismic signals generated by ocean waves in Antarctica. Credit: Rob Anthony, USGS

More than two decades of data analyzed

Robert Anthony, who recently received a Ph.D. from CSU's Department of Geosciences and is now a Mendenhall Research Fellow at the U.S. Geological Survey's Albuquerque Seismological Laboratory, said that the team looked at 23 years of seismic data from Palmer Station on the Antarctic Peninsula and East Falkland Island near South America. They looked specifically at seismic signals generated by ocean waves.

"We were able to show that storm and ocean wave activity in the Drake Passage, the ocean basin between the Antarctic Peninsula and South America, increases during positive phases of the Southern Annular Mode, " he explained. "We were also able to verify that sea ice cover does indeed impede ocean swell from reaching the coastline by showing which regions of sea ice impact the intensity of microseisms. This type of analysis may be useful for future applications of using seismic records to track the strength of sea ice over large regions, which has been difficult to determine from satellite observations."

Anthony, lead author of the study, said that based on the findings, the positive phase of the Southern Annular Mode may contribute to ice shelf weakening and potential collapse events by:

- increasing air temperatures on the Antarctic Peninsula, which can enhance surface melting of ice shelves,
- driving off sea ice, which enables ocean waves to directly impact ice shelves, and
- generating stronger wave events.

Researchers had previously speculated on a link between ice shelf collapse and the Southern Annular Mode, based mainly on elevated air temperatures. But the CSU team now suspects that the reduction of sea ice and strong wave events in the Drake Passage could also play a role in rapid collapse events, such as the dramatic collapse of the Larsen A ice shelf in 1995 and, perhaps, the ongoing fracturing of the Larsen C ice shelf.

The team's next steps include looking more closely at specific ocean swell events and sea ice conditions during known ice shelf collapses and large iceberg calving events.

More information: Robert E. Anthony et al, Links between

atmosphere, ocean, and cryosphere from two decades of microseism observations on the Antarctic Peninsula, *Journal of Geophysical Research: Earth Surface* (2017). DOI: 10.1002/2016JF004098