Feedback loop that is melting ice shelves in West Antarctica revealed

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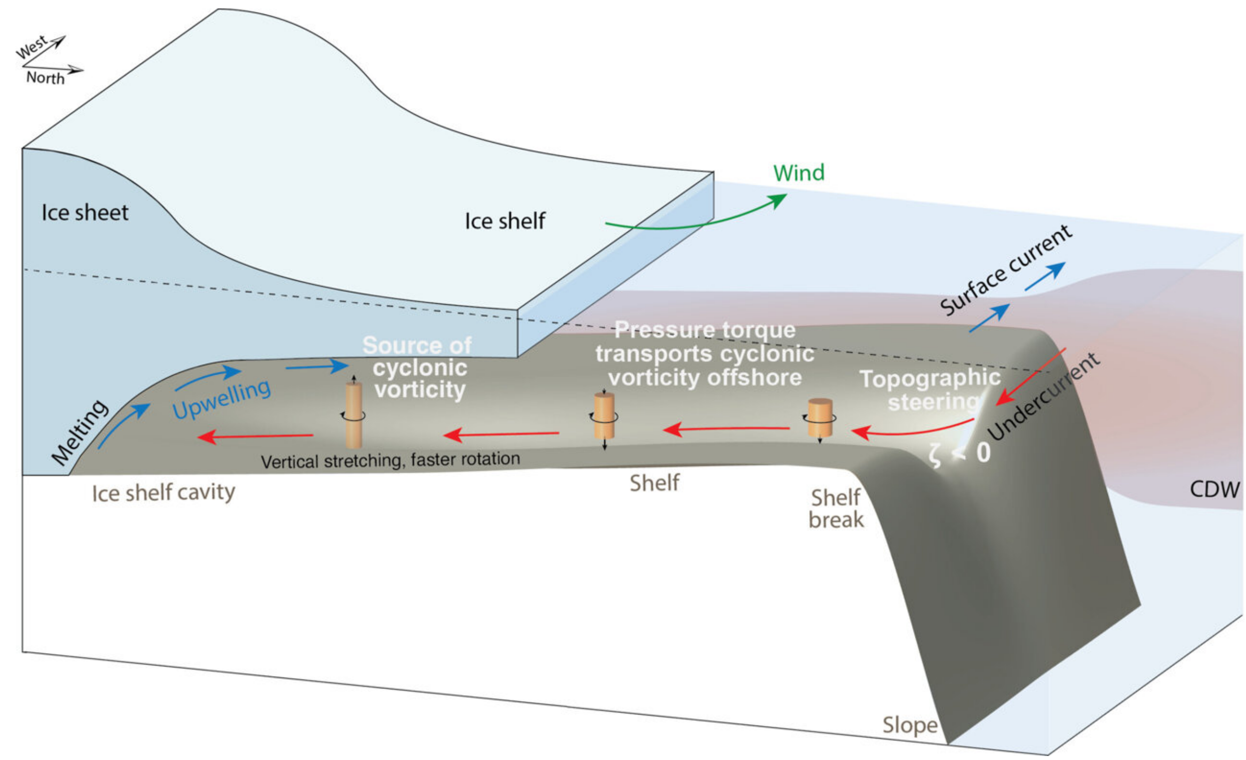

Schematic illustrating the mechanism of Antarctic Slope Undercurrent formation. Credit: *Science Advances* (2024). DOI: 10.1126/sciadv.adl0601

New research has uncovered a feedback loop that may be accelerating the melting of the floating portions of the West Antarctic Ice Sheet, pushing up global sea levels.

The study, titled "Antarctic Slope Undercurrent and onshore heat transport driven by ice shelf melting" and published in *Science Advances*, sheds new light on the mechanisms driving the melting of ice shelves beneath the surface of the ocean, which have been unclear until now.

The West Antarctic Ice Sheet has been losing mass in recent decades, contributing to global sea level rise. If it were to melt entirely, global sea levels would rise by around five meters.

It's known that Circumpolar Deep Water (CDW), a water mass that is up to 4°C above local freezing temperatures, is flowing beneath the ice shelves in West Antarctica and melting them from below. Since so much of the West Antarctic Ice Sheet lies below sea level, it is particularly vulnerable to this warm water intrusion and may further retreat in the future.

Previous observations and models have revealed that eastward undercurrents are transporting this warm water to cavities under the ice shelves. Despite its significance, the mechanism driving this undercurrent has remained elusive.

Professor Alberto Naveira Garabato, from the University of Southampton, a co-author of the paper, said, "Our findings suggest a positive feedback loop: as the ice shelf melts more rapidly, more freshwater is produced, leading to a stronger undercurrent and more heat being transported toward the ice shelves."

"This cycle could speed up the melting of ice shelves, potentially making the West Antarctic Ice Sheet less stable in the future."

Researchers from the University of California Los Angeles, MIT and the University of Southampton, used high-resolution simulations to investigate the dynamics of the undercurrent.

Dr. Alessandro Silvano from the University of Southampton, a co-author on the study, said, "These simulations reveal that this deep current conveying warm waters toward the ice shelves is driven by the very same ice shelf melting that such warm waters cause."

Their models suggest that when the warm CDW interacts with the ice shelf, it melts the ice and mixes with the lighter, melted freshwater.

This water then rises through the layers of water above it. As it does, it spreads out and stretches the layer of CDW vertically. This stretching creates a swirling motion in the water.

If there's a trough (a kind of underwater valley) near the coast, this swirling motion is then carried away from the ice shelf cavity toward the edge of the shelf by the movement of pressure within the water. This movement helps drive a current along the slope of the seafloor, directing more warm water toward the ice shelf.

The underwater current forms a bit farther away from the ice shelf, so as more ice melts, the current gets stronger, carrying even more warm water toward the ice shelf.

Dr. Silvano added, "Scientific models that don't include the cavities under ice shelves are probably overlooking this positive feedback loop. Our results suggest it's an important factor that could affect how quickly ice shelves melt and how stable the West Antarctic Ice Sheet is over time."

More information: Yidongfang Si et al, Antarctic Slope Undercurrent and onshore heat transport driven by ice shelf melting, *Science Advances* (2024). DOI: 10.1126/sciadv.adl0601

Provided by University of Southampton