

Zombie ice from Greenland will raise sea level 10 inches

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A boat navigates at night next to large icebergs in eastern Greenland on Aug. 15, 2019. Zombie ice from the massive Greenland ice sheet will eventually raise global sea level by at least 10 inches (27 centimeters) on its own, according to a study released Monday, Aug. 29, 2022. Zombie or doomed ice is still attached to thicker areas of ice, but it's no longer getting fed by those larger glaciers. Credit: AP Photo/Felipe Dana, File

Greenland's rapidly melting ice sheet will eventually raise global sea level by at least 10.6 inches (27 centimeters)—more than twice as much as previously forecast—according to a study published Monday.

That's because of something that could be called zombie ice. That's doomed ice that, while still attached to thicker areas of ice, is no longer getting replenished by parent glaciers now receiving less snow. Without replenishment, the doomed ice is melting from climate change and will inevitably raise seas, said study co-author William Colgan, a glaciologist at the Geological Survey of Denmark and Greenland.

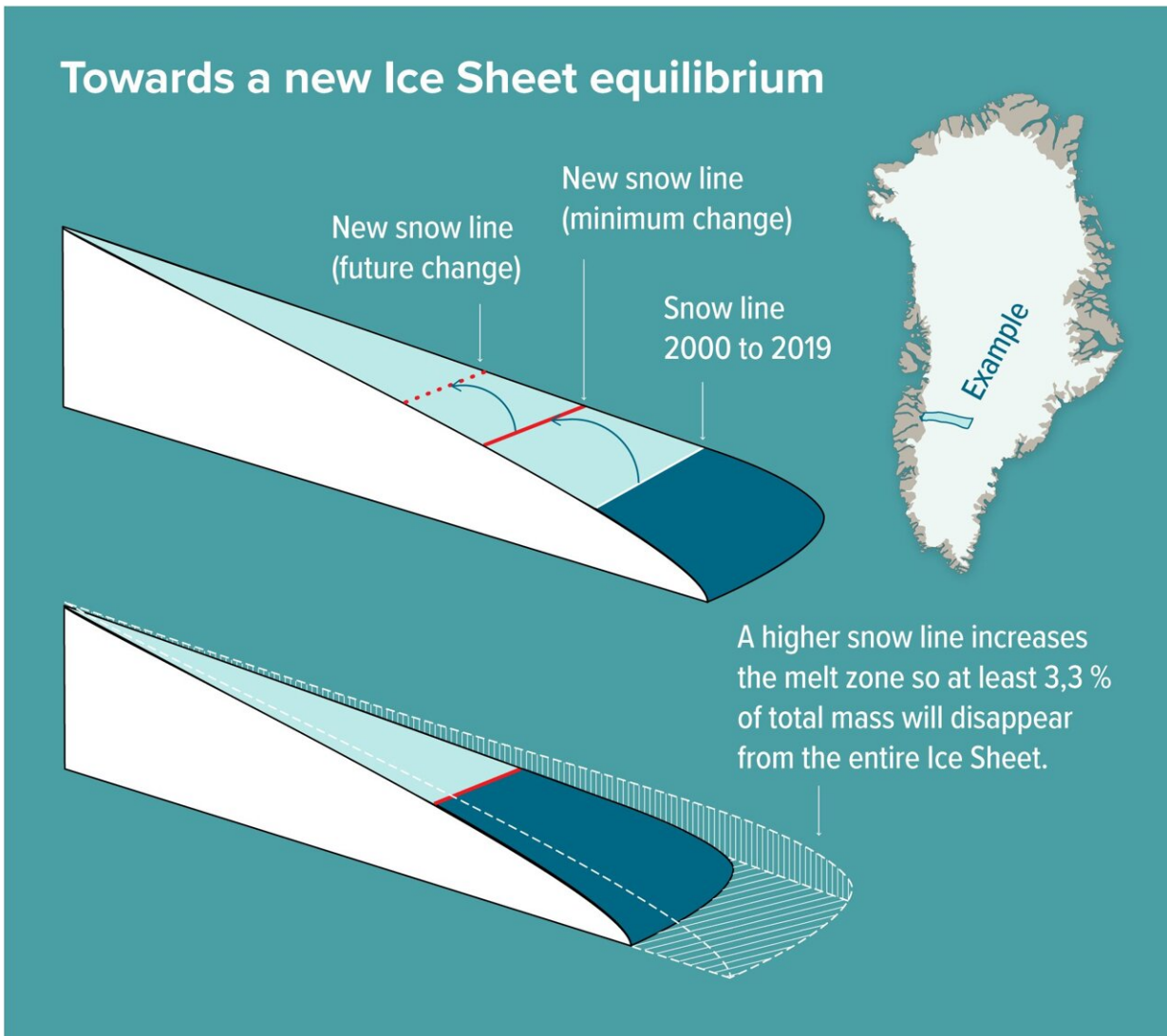
"It's dead ice. It's just going to melt and disappear from the ice sheet," Colgan said in an interview. "This ice has been consigned to the ocean, regardless of what climate (emissions) scenario we take now."

Study lead author Jason Box, a glaciologist at the Greenland survey, said it is "more like one foot in the grave."

The unavoidable ten inches in the study is more than twice as much sea level rise as scientists had previously expected from the melting of Greenland's ice sheet. The study in the journal *Nature Climate Change* said it could reach as much as 30 inches (78 centimeters). By contrast, last year's Intergovernmental Panel on Climate Change report projected a range of 2 to 5 inches (6 to 13 centimeters) for likely sea level rise from Greenland ice melt by the year 2100.

What scientists did for the study was look at the ice in balance. In perfect equilibrium, snowfall in the mountains in Greenland flows down and recharges and thickens the sides of glaciers, balancing out what's melting on the edges. But in the last few decades there's less replenishment and more melting, creating imbalance. Study authors looked at the ratio of what's being added to what's being lost and calculated that 3.3% of Greenland's total ice volume will melt no matter

what happens with the world cutting carbon pollution, Colgan said.



In the recent (2000–2019) climate, the Greenland ice has built up a disequilibrium which will inevitably correct itself by reducing total mass by at least 3.3 percent in order to regain equilibrium at a new average snow line in a higher alteration. Credit: The Geological Survey of Denmark and Greenland, GEUS

"I think starving would be a good phrase," for what's happening to the ice, Colgan said.

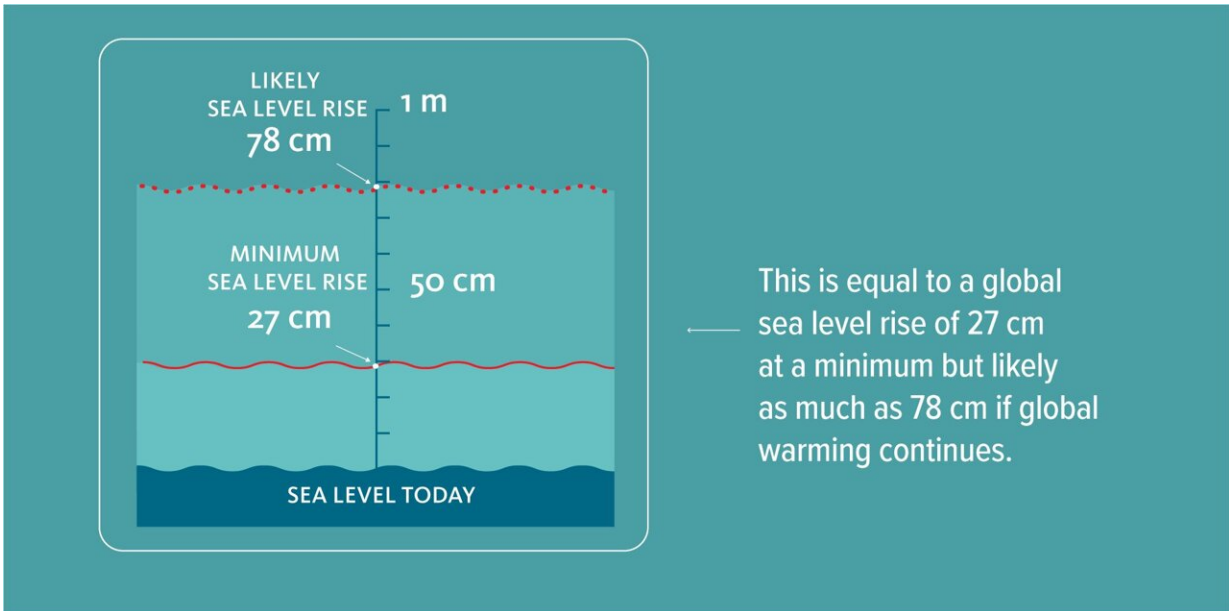
One of the study authors said that more than 120 trillion tons (110 trillion metric tons) of ice is already doomed to melt from the warming ice sheet's inability to replenish its edges. When that ice melts into water, if it were concentrated only over the United States, it would be 37 feet (11 meters) deep.

The figures are a global average for sea level rise, but some places further away from Greenland would get more and places closer, like the U.S. East Coast, would get less. Although 10.6 inches may not sound like much, this would be over and above high tides and storms, making them even worse, so this much sea level rise "will have huge societal, economic and environmental impacts," said Ellyn Enderlin, a geosciences professor at Boise State University, who wasn't part of the study.

"This is a really large loss and will have a detrimental effect on coastlines around the world," said NYU's David Holland who just returned from Greenland, but is not part of the study.

This is the first time scientists calculated a minimum ice loss—and accompanying sea level rise—for Greenland, one of Earth's two massive ice sheets that are slowly shrinking because of climate change from burning coal, oil and natural gas. Scientists used an accepted technique for calculating minimum committed ice loss, the one used on mountain glaciers for the entire giant frozen island.

Pennsylvania State University glaciologist Richard Alley, who wasn't part of the study but said it made sense, said the committed melting and sea level rise is like an ice cube put in a cup of hot tea in a warm room.



The minimum global sea level rise and likely global sea level rise resulting from the committed mass loss from the Greenland Ice Sheet. Credit: The Geological Survey of Denmark and Greenland, GEUS

"You have committed mass loss from the ice," Alley said in an email. "In the same way, most of the world's mountain glaciers and the edges of Greenland would continue losing mass if temperatures were stabilized at modern levels because they have been put into warmer air just as your ice cube was put in warmer tea."

Time is the key unknown here and a bit of a problem with the study, said two outside ice scientists, Leigh Stearns of the University of Kansas and Sophie Nowicki of the University of Buffalo. The researchers in the study said they couldn't estimate the timing of the committed melting, yet in the last sentence they mention, "within this century," without supporting it, Stearns said.

Colgan responded that the team doesn't know how long it will take for all the doomed ice to melt, but making an educated guess, it would probably be by the end of this century, or at least by 2150.

Colgan said this is actually all a best case scenario. The year 2012 (and to a different degree 2019) was a [huge melt year](#), when the equilibrium between adding and subtracting ice was most out of balance. If Earth starts to undergo more years like 2012, Greenland melt could trigger 30 inches (78 centimeters) of sea level rise, he said. Those two years seem extreme now, but years that look normal now would have been extreme 50 years ago, he said.

"That's how climate change works," Colgan said. "Today's outliers become tomorrow's averages."

More information: Jason E. Box et al, Greenland ice sheet climate disequilibrium and committed sea-level rise, *Nature Climate Change* (2022). DOI: 10.1038/s41558-022-01441-2 , www.nature.com/articles/s41558-022-01441-2

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