

Ice mass the size of Greenland overlooked in climate models

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Far more of Earth's water was locked up as ice at the height of the last ice age than previously thought, and current climate change models may need to be adjusted to account for it, according to a new study.

The research is the latest salvo from geophysicists who are re-examining assumptions made about Earth's crust by climatologists calculating ancient sea levels. Those levels are commonly used to fine-tune models that attempt to predict how much Earth's average [sea level](#) may rise because of [climate change](#).

The latest work, published this week in the journal *Nature Geoscience*, looks at a widely used record of fossilized coral in the ocean around Barbados. The highly accurate dating and long time span of those fossils have allowed scientists to estimate fluctuations in sea level, and thus [ice](#) content, by extrapolating from variations in the ratio of [oxygen isotopes](#). Those calculations suggest that the average [global sea level](#) at the height of the last glacial maximum - 20,000 to 26,500 years ago - was as much as 394 feet below current levels.

Jacqueline Austermann, a geophysicist at Harvard University, suggests that level is about 33 feet too high - the equivalent of the ice currently covering Greenland.

Her calculation of a larger sea water deficit is based on a more sophisticated look at the way Earth's crust flexes and moves in response to dynamics of its mantle.

"If you melt ice, sea level doesn't change at the same rate everywhere," Austermann said. "You have local effects." For example, the weight of ice pushes land masses down, and they rebound. Ocean bottoms likewise are compressed or released by varying weights of [sea water](#).

Scientists who calculate ancient sea levels have accounted for some movement of Earth's crust associated with this so-called [glacial isostatic adjustment](#). But they have not adequately accounted for other aspects of crust movement driven by long-term dynamics of Earth's mantle, according to Austermann and her team, led by her Ph.D. adviser, Harvard geophysicist Jerry Mitrovica. Significantly, the study noted, Barbados lies at an area where one plate is sliding under another.

Mitrovica's Harvard team factored in such phenomena as the viscosity of the crust - how well various features of the uppermost layer of Earth slide and move. (Earth may be terra firma in our life spans, but its mantle is fluid over the long run. Picture a slowly simmering gruel covered by a thin, constantly crackling crust.)

Though it may seem remarkable to "overlook" as much ice as covers Greenland, that miscalculation is only about a 10 percent error, when compared with the shifting volumes of ice during the time period, Austermann said.

"It's still a significant amount," she said. "I guess that's why this study is so important, because it shows you can get such a large amount of ice missing just by re-evaluating the record."

A similar reevaluation, in which Mitrovica was involved, was published last month in *Science*. It suggested that a common geological marker for marine flooding during the mid-Pliocene epoch, about 3 million years ago, can be explained by a warping of Earth's crust along the Eastern Seaboard of the U.S., possibly without any rise in sea level.

David B. Rowley, a geophysicist at the University of Chicago and lead author of the study, suggested that these sedimentary layers from New Jersey to Florida may not accurately reflect ancient sea levels. Scientists had previously estimated that these seaboard formations implied sea levels rose by 56 to 174 feet after atmospheric carbon dioxide reached levels similar to modern times. Such a rise would imply catastrophic collapse of the ice sheets of Greenland and the West Antarctic, and possibly the East Antarctic as well.

Rowley's calculations show that sea levels either did not change or shifted only about 82 feet.

"It allows for the possibility that there is significant melting of the East Antarctic Ice Sheet," Rowley said. "Or it allows for a simple interpretation of no melting."

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