ANTARCTIC SNOWFALL WON'T OFFSET ICE LOSS

odels have shown that climate change will likely increase ice discharge from Antarctica, but would also increase snowfall on the icy continent. Although intuition suggests that more snow might at least partially compensate for the ice loss and mitigate sea-level rise, a new study suggests that extra snowfall would increase the rate that ice breaks off into the ocean.

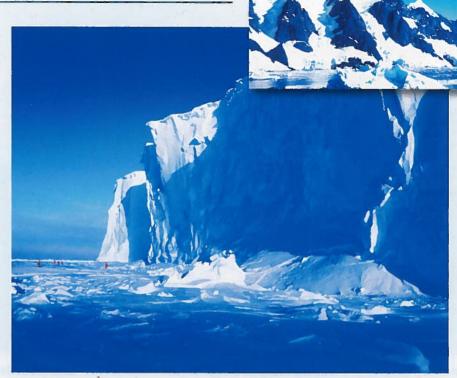
There are several ways that a warming atmosphere could increase ice discharge: warming seas melt the undersides of ice shelves; ice softens due to surface warming; meltwater lubricates the underlying bedrock; and loss of adjacent ice shelves allows ice streams — narrow, faster-moving sections of ice — to accelerate toward the sea. Now there is yet another mechanism threatening ice sheets.

Increased snowfall on Antarctica will create a steeper grade near the grounding line — the line where ice ceases to ride on land and begins floating on the sea. That snowfall-induced steepness could as much as triple ice discharge, according to the new study in Nature.

Led by climate scientist Ricarda Winkelmann, a team of researchers at the Potsdam Institute for Climate Impact Research in Germany ran computer simulations using the Potsdam Parallel Ice Sheet Model (PISM-PIK) to model Antarctic ice shelves and ice discharge out to the year 2500, with a focus on the effects of snow accumulation on the grounding line.

The researchers found that between 30 and 65 percent of ice gained from the expected additional snowfall would be lost by ice breaking off into the ocean. "People reported this effect in 1999, but they estimated it to be 10 percent of the additional snowfall," says climate scientist Anders Levermann, one of the Potsdam researchers and lead author of the sea-level change chapter in the Intergovernmental Panel on Climate Change's upcoming Fifth Assessment Report.

Snowfall on floating ice simply makes the ice float a little lower, whereas snowfall on land continues to pile up.



Snowfall on Antarctica is expected to increase as global temperatures increase. Rather than offsetting ice loss, however, the increased snowfall could as much as triple the rate of Antarctic ice discharge.

Specifically, a given amount of snowfall on land increases elevation by nine times as much as the same amount of snowfall would increase the elevation of floating ice, the researchers wrote.

"So you get a difference in the surface elevation [between the ice on land and the ice in the water]," Levermann says. "The difference in the ice height is driving the flow of the ice."

The authors say that their results only provide a conservative estimate of potential ice discharge. The ice loss could actually be greater because of the dynamics of marine ice sheets: an initial perturbation can destabilize the entire ice sheet.

One of the snags with the new study is that it gives a projection based on other projections, says Andrew Monaghan, a climatologist who studies snowfall, temperature and Antarctica at the University Corporation for Atmospheric Research, in Boulder, Colo., and was not involved in the research. "Climate models have a lot of uncertainties, and they typically behave the worst over Antarctica for a variety of reasons," Monaghan says.

However, most climate models agree that Antarctica can expect more snowfall, he says. "I think the study should be viewed as more of a hypothetical [case], but I also think that it's a reasonably plausible scenario for the Antarctic ice sheet, with a lot of uncertainty," he says.

"I think it's a very significant paper," says Richard Cullather, a climatologist at the University of Maryland at College Park, who studies sea ice and precipitation in polar regions for NASA's Goddard Space Flight Center in Maryland and was also not involved in the study. "The PISM-PIK model is pretty well-respected in the community," he adds.

Dynamic ice sheet models are "fairly new contraptions," so PISM-PIK has its imperfections, Cullather notes. But "I think this is going to be an excellent starting point for the community to determine what the sea-level rise will be from Antarctica," he says, adding that a good next step might be to "retool" the model to simulate individual Antarctic glaciers.

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18 • EARTH April 2013