Greenland Ice: The warmer it gets the faster it melts
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Greenland might be especially vulnerable to melting because that area of the Earth sees about 50 percent more warming than the global average. Arctic sea ice, when it exists, reflects the sun’s energy back through the atmosphere, but when the sea ice melts and there is open water, the water absorbs the sun’s energy and reradiates it back into the air as heat. Arctic sea ice coverage has decreased over the last few decades, and that decrease will probably continue in the future, leading to accelerated temperature rise over Greenland. Floating ice does not add to sea level, but the Greenland Ice Sheet rests on bedrock that is above sea level.

Feedbacks in the climate system cause accelerated temperature rise over the Arctic. Other feedbacks in the Greenland Ice Sheet that contribute to melting include height-melting feedback. A warm year in Greenland causes more melt around the edges of the ice sheet, lowering the surface. The atmosphere is warmer at lower altitudes, so the now lower surface experiences even more melting. This process can lead to accelerated ice melt and sea level rise.

Another form of feedback occurs because ice sheets are large masses that want to spread. This spreading can either help preserve the ice sheet by allowing it to adjust to increased temperature or accelerate ice melting by moving ice to lower, warmer, places.

"Many studies of sea level rise don’t take into account feedbacks that could cause rapid sea level rise," said Applegate. "We wanted to look at the effects of those feedbacks."

The researchers looked at two models of the Greenland ice sheet that include some of the important feedbacks. The first model is a three-dimensional ice sheet model. The second model...
looks at a transect across the island and was
developed by Byron Parizek, associate professor of
geosciences and mathematics, Penn State Dubois.
To run both models, Robert Nicholas, research
associate, EESI, estimated how much warming
might take place over Greenland using results from
global climate models.

Both the three-dimensional and transect models
showed that the time necessary for ice mass loss
from the Greenland ice sheet decreases steeply
with increases in temperature. Shorter time
scales—faster melting—imply faster sea level rise.
The interplay between the height-melting feedback
and ice flow causes this acceleration.

"Our analysis suggests that the benefits of reducing
greenhouse gas emissions, in terms of avoided sea
level rise from the Greenland Ice Sheet, may be
greatest if emissions reductions begin before large
temperature increases have been realized," the
researchers state in a recent issue of *Climate
Dynamics*.

Currently, about a billion people—1 percent of the
world population—live in areas that would be flooded
by a three-foot sea level rise.

"If we are going to do something to mitigate sea-
level rise, we need to do it earlier rather than later,"
said Applegate. "The longer we wait, the more
rapidly the changes will take place and the more
difficult it will be to change."

Provided by Pennsylvania State University
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