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Complexity of glacier ice loss captured in new estimates of sea level rise

Greenland's four major glaciers could contribute 19 to 30 mm to sea level rise by 2200, according to a new study. The researchers developed a sophisticated model which provides new insight into the effects of climate change on Greenland's glaciers, by capturing the complex processes involved in their movement and melt.

Ice loss from Greenland's Ice Sheet has been increasing over the past decade, raising concerns about rising sea levels. Changes in sea levels are caused not only by the surface of the ice sheet melting, but also by pieces of the ice sheet breaking off into the ocean, known as 'calving'. This mainly occurs in fast-flowing glaciers that terminate at the sea, which are highly sensitive to changes in the atmosphere and the ocean.

The study, conducted under the EU's ice2sea project[1], presents a new state-of-the-art model to indicate the movements and changes of four major Greenland glaciers that terminate at the sea.

Using highly detailed data of the glaciers' topography (surface features), the model captured complex processes, including underwater melting, calving and 'basal lubrication', whereby the base of the glacier is lubricated by melting water, allowing the glacier to slide. The researchers estimated the amount of ice loss from the glaciers and subsequent sea level rise for the period 2000-2200, assuming mid-range climate change, specifically, the Intergovernmental Panel on Climate Changes's A1B scenario.

The model predicted that all four glaciers would retreat, become thinner and lose ice mass, although at different rates. In combination, the glaciers would lose 30 to 47 gigatonnes of ice per year for the first 100 years. For comparison, this is roughly the same amount as a third to a half of the water contained in Lake Geneva. From 2100 to 2200, ice loss would increase to about 34 to 54 gigatonnes per year. This would lead to the sea level rising by 8.5 to 13.1 mm by 2100, and 18.6 to 30.00 mm by 2200.

A second scenario used a more extreme temperature rise (4.5°C by 2100), and predicted that the loss of ice mass would increase by more than 50 percent. This would lead to a sea level rise of 29 to 49 mm by 2200.

Around 80% of the ice loss is considered likely to be caused by the movement of the glaciers and ice entering the ocean. These losses do not occur gradually over the years; there are likely to be several quick bursts of retreat, when several tens of gigatonnes of ice fall into the sea, as well as periods of little loss.

This suggests that current short-term trends in accelerated ice loss cannot be assumed to continue at the same, constant rate into the future, and predictions must account for these irregular patterns of glacier retreat and ice loss.

Although the episodes of rapid retreat are expected to occur at the same locations, they will be at different times. The study suggests that these changes are related to the shape of the fjord in which the glacier sits, and the shape of the rock beneath the ice.

The model has produced the first estimate of four of Greenland's major glaciers' contribution to sea level rise that takes into account the complex dynamics of glacier movement and ice loss. To further its development, it also needs to be applied to other glaciers that terminate at the sea.

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1.ice2sea is supported by the European Commission under the Seventh Framework Programme. See: www.ice2sea.eu