Major Antarctic glacier is 'past its tipping point'

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A major Antarctic glacier has passed its tipping point, according to a new modelling study. After losing increasing amounts of ice over the past decades, it is poised to collapse in a catastrophe that could raise global sea levels by 24 centimetres.

Pine Island glacier (PIG) is one of many at the fringes of the West Antarctic ice sheet. In 2004, satellite observations showed that it had started to thin, and that ice was flowing into the Amundsen Sea 25 per cent faster than it had 30 years before.

Now, the first study to model changes in the ice sheet in three dimensions shows that PIG has probably passed a critical "tipping point" and is irreversibly on track to lose 50 per cent of its ice in as little as 100 years, significantly raising global sea levels.

The team that carried out the study admits their model can represent only a simplified version of the physics that govern changes in glaciers, but say that if anything, the model is optimistic and PIG will disappear faster than it projects.

Richard Katz of the University of Oxford and colleagues developed the model to explore whether the retreat of the "grounding line" – the undersea junction at which a floating ice shelf becomes an ice sheet grounded on the sea bed – could cause ice sheets to collapse.

Warm seas

Climate change is warming the Amundsen Sea, which is at the southern margin of the Pacific Ocean. As rising sea levels push the warm water beneath the ice shelves, it melts them from

below, pushing the grounding line higher up the continental shelf.

By raising sea levels, and therefore the grounding line, in their model, Katz's team were able to find the point of no return beyond which the glacier would be unable to recover. That's because the Antarctic sea bed has a small lip in it: it rises slowly up the continental shelf, then makes a slight dip before rising again to the shoreline. The researchers found that as long as the grounding line is on the outer rise of the sea bed, before the lip, small changes in climate lead to correspondingly small changes in the glacier's ice volume.

But as soon as the grounding line moves over the lip and starts to move down into the dip in the sea bed, the situation changes critically. "Once the grounding line passes the crest, a small change in the climate causes a rapid and irreversible loss of ice," says Katz.

Past the point of no return

According to Katz's model, the grounding line probably passed over the crest in 1996 and is now poised to enter a period of accelerated shrinking.

The model suggests that within 100 years, PIG's grounding line could have retreated over 200 kilometres. "Before the retreating grounding line comes to a rest at some unknown point on the inner slope, PIG will have lost 50 per cent of its ice, contributing 24 centimetres to global sea levels," says Richard Hindmarsh of the British Antarctic Survey, who did not participate in the study.

This assumes that the grounding line does eventually stabilise, after much of PIG is gone. In reality, PIG could disappear entirely, says Hindmarsh. "If Thwaite's glacier, which sits alongside PIG, also retreats, PIG's grounding line could retreat even further back to a second crest, causing sea levels to rise by 52 centimetres." The model suggests Thwaite's glacier has also passed its tipping point.

Observations already show that the model severely underestimates the rate at which PIG's grounding line is retreating, says Katz. "Ours is a simple model of an ice sheet that neglects some important physics," says Katz. "The take-home message is that we should be concerned about tipping points in West Antarctica and we should do a lot more work to investigate," he says.

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