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Unexpected Antarctic ice melt may trigger 2 metre sea level rise

We're on thin ice when it comes to sea level rise
Colin Monteath/Hedgehog House/Minden Pictures

A massive rise in sea level is coming, and it will trigger climate chaos around the world. That was the message from a controversial recent paper by climate scientist James Hansen. It was slated by many for assuming – rather than showing – that sea level could rise between 1 and 5 metres by 2100.

But now, just a week after being formally published, it is being backed up by another study. "He was speculating on massive fresh water discharge to the ocean that I don't think anybody thought was possible before," says Rob DeConto of the University of Massachusetts Amherst. "Now we're publishing a paper that says these rates of fresh water input are possible."

DeConto's findings suggest that even if countries meet the pledges made as part of the UN climate agreements in Paris last year, global sea level could still rise 1 metre by 2100. If emissions keep climbing it could go up more than 2 metres. North America would be especially hard hit, because gravitational effects mean that ice loss from Antarctica will lead to bigger local increases for the US East Coast.

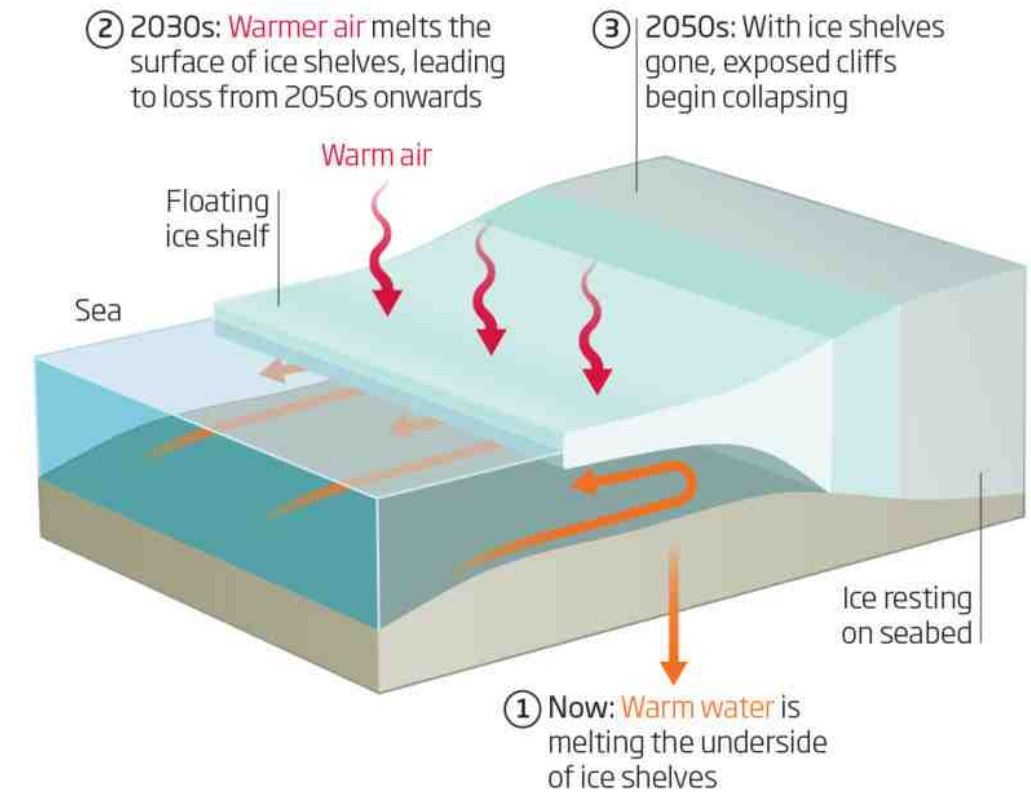
"Today we're measuring global sea level rise in millimetres per year," DeConto says. "We're talking about the potential for centimetres per year just from [ice loss in] Antarctica."

Exposed ice

So far, almost all estimates of global sea level rise by 2100 have assumed that Antarctica will gain rather than lose ice, thanks to increased snowfall compensating for any melting at the margins. However, the Intergovernmental Panel on Climate Change warned in its latest report that this could be an underestimate, because the computer models used may not be able to predict rapid changes in Antarctica's ice.

Now DeConto has included factors in his model that other studies have lacked. First, floating ice shelves around Antarctica will soon be exposed to above-zero summer air temperatures, speeding their melt, he says. Second, once the shelves are gone, the huge ice cliffs that remain will begin to collapse.

Working with David Pollard of Pennsylvania State University, DeConto calibrated this model using data on past sea level rises during warm periods 120,000 and 3 million years ago. Their model is the first to match what is thought to have happened during these periods.



They applied their model to several greenhouse gas emission scenarios and found that if emissions rapidly grow in future years, Antarctica alone could contribute well over 1 metre to global sea level by 2100. When this finding is combined with IPCC estimates, it suggests that we could be looking at a rise of over 2 metres by the end of the century, and 20 metres by 3500.

If countries meet the commitments they made as part of the Paris climate agreement, and continue to cut emissions after the agreement ends in 2030, then the world should be on track for a less severe rise in sea level. But DeConto's model suggests that even this might not be enough to prevent rises that would devastate Miami and other low-lying cities within the lifetime of young people today.

Rapidly reducing global emissions could, in principle, avoid most Antarctic ice loss, says DeConto. In practice, we wouldn't be able to replace fossil fuel infrastructure fast enough, even if the political will was there. "That's not going to happen," he says.

Collapsing cliffs

DeConto's model doesn't include some mechanisms that Hansen argues would make ice melt even worse, but it also omits some processes that could reduce ice loss. As Richard Hindmarsh of the British Antarctic Survey in Cambridge notes, the falling ice debris might build up in front of the collapsing cliffs, and buttress them against further collapse.

"I don't believe sea level will rise more than a metre by 2100," says Hindmarsh, whose recent research has suggested that ice loss from Antarctica this century will be minimal. How ice breaks is much less well understood than how it melts, and Hindmarsh thinks DeConto's model overestimates the impact of ice cliffs collapsing.

But DeConto says that Hindmarsh's work predicts future ice loss based on what's happened so far, and doesn't take into account processes like ice surface melt that haven't kicked in yet.

In fact, glaciologist Richard Alley of Pennsylvania State University says DeConto's model may even be an underestimate. "The new work should not be considered to be a 'worst case' scenario," he says.

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'Drastic' Antarctic melt could double global sea-level rise

By Matt McGrath Environment correspondent

- 8 hours ago
- From the section Science & Environment

Image copyright SPL
Image caption The latest model suggests that Antarctic melting could double projections of sea-level rise

Global sea levels could rise by more than double the current best estimate, according to a new analysis of climate change in Antarctica.

The modelling assessment says that Antarctic melting alone could contribute more than a metre to sea level by the end of this century.

By 2500, according to the study, the same source could cause levels across the world to rise by 13m.

The authors say that rapid cuts in carbon emissions could limit this risk.

Competing ideas

In 2013, the Intergovernmental Panel on Climate Change (IPCC) predicted that, without any restrictions on carbon emissions, the seas around the world likely rise by up to 98cm by 2100.

However, the IPCC estimates contained a minimum contribution from Antarctica.

Other analyses since then have projected bigger increases, with a recent study suggesting that the oceans were rising faster than at any time in the past 2,800 years and by 2100 they could be up to 1.31m higher.

The exact level of Antarctica's impact on these projections has been vigorously debated. Late last year, a research paper suggested that projections of a contribution of a metre or more were not plausible.

But this new study argues that by 2100 the world could see 1.14m of sea-level rise from Antarctica alone.

Additions to the model

The scientists say that their model is able to provide a more accurate prediction because it incorporates the impacts of some physical processes for the first time.

While other models have focussed on the impact of warmer waters melting the ice shelves from below, this new study also includes the effect of surface melt-water and rain trickling down from above and fracturing supporting ice, hastening its slide to the sea.

The model also calculates the impact of the disintegration of floating ice shelves. If this happens, it will reveal walls of ice so tall that they cannot support their own weight.

The scientists involved expect that these extra factors will kick in over the coming decades, as warming from the atmosphere (not just from warmer waters below) becomes the dominant driver of ice loss.

Image copyright SPL
Image caption The collapse of ice cliffs could be a significant factor in the new projection

"One reason that other models didn't include the atmospheric warming is because it hasn't started to happen just yet," said co-author Dr David Pollard from Penn State University, US.

"In Antarctica, around the edges at sea level, it's just beginning to get up to the melt point in summer.

"With that warming, the flanks of Antarctica will start to melt drastically in about 50 to 100 years - and then it will start to kick in according to our model."

The authors believe that they have demonstrated the accuracy of the new model by correctly replicating sea-level rise in warm periods, millions of years into the past.

"Recently, we looked at the long-standing problem posed by geological evidence that suggests sea level rose dramatically in the past, possibly up to 10 to 20 metres around 3 million years ago, in the Pliocene," said Dr Pollard.

"Existing models couldn't simulate enough ice-sheet melting to explain that."

'Right questions'

If the world continues to emit "business as usual" levels of carbon dioxide over the coming decades, the scientists argue that sea-level rise will be double what has already been estimated for the coming 100 years.

"If these processes do kick in and they end up being as important as we think that they could be, then they really do have a big impact," said Prof Robert DeConto from the University of Massachusetts, Amherst.

"West Antarctica is responding very soon in these simulations and that ends up having a big impact on North America in particular."

Other researchers have praised the development of the new model for including impacts such as surface melt water and ice-cliff collapse, but they are uncertain about the conclusions.

"I have no doubt that on a century to millennia timescale, warming will make these processes significant in Antarctica, as well as Greenland, and drive a very significant Antarctic contribution to sea-level rise," commented Prof David Vaughan of the British Antarctic Survey.

"The big question for me is, how soon could this all begin, and could it be early enough to drive substantially higher sea levels by 2100? I'm not sure, but these guys are definitely asking the right questions."

The authors believe that there is "good news" in their report. If global emissions of carbon are curtailed significantly then the extra factors that substantially boost Antarctic melting will be avoided.

Seas will continue to rise, but not at the runaway rates suggested by this paper, which has been published in the journal Nature.