

Climate emergency: world 'may have crossed tipping points'

Warning of 'existential threat to civilisation' as impacts lead to cascade of unstoppable events

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'Part of the west Antarctic ice sheet may be in irreversible retreat,' said one of the researchers. Photograph: Handout/AFP/Getty Images

The world may already have crossed a series of climate tipping points, according to a stark warning from scientists. This risk is “an existential threat to civilisation”, they say, meaning “we are in a state of planetary emergency”.

Tipping points are reached when particular impacts of global heating become unstoppable, such as the runaway loss of ice sheets or forests. In the past, extreme heating of 5C was thought necessary to pass tipping points, but the latest evidence suggests this could happen between 1C and 2C.

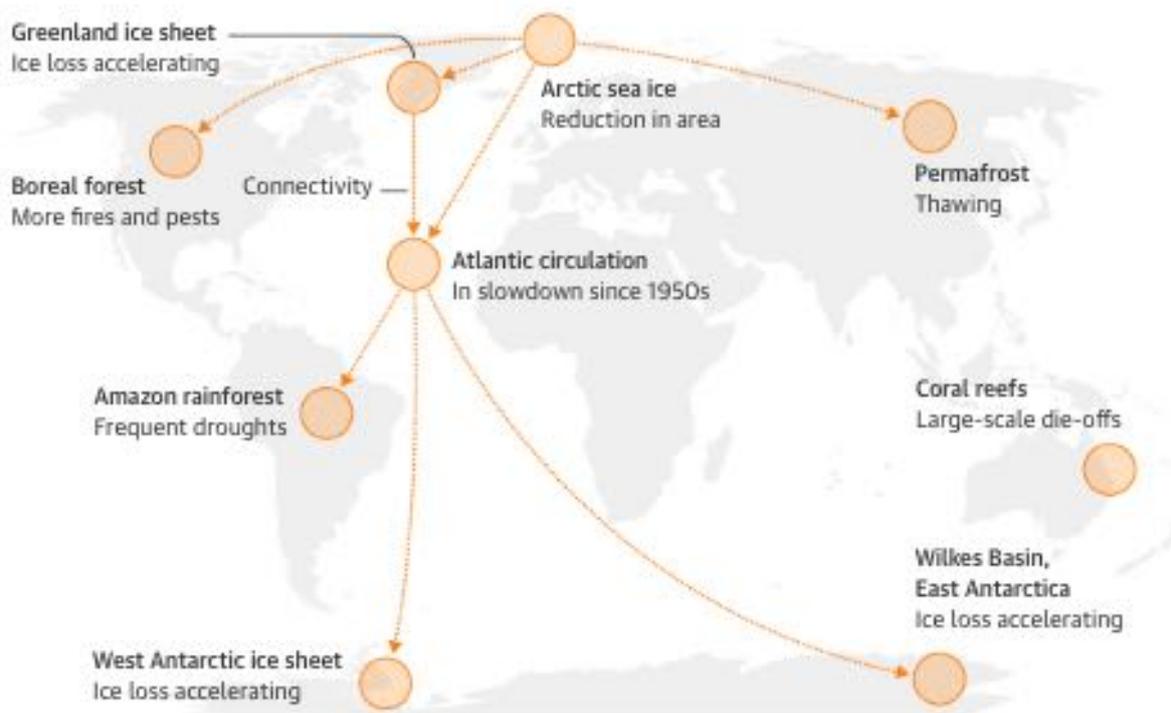
The planet has already heated by 1C and the temperature is certain to rise further, due to past emissions and because **greenhouse gas levels are still rising**. The scientists further warn that one tipping point, such as the release of

methane from thawing permafrost, may fuel others, leading to a cascade.

The researchers, writing in a [commentary article in the journal Nature](#), acknowledge that the complex science of tipping points means great uncertainty remains. But they say the potential damage from the tipping points is so big and the time to act so short, that “to err on the side of danger is not a responsible option”. They call for urgent international action.

“A saving grace is that the rate at which damage accumulates from tipping could still be under our control to some extent,” they write. “The stability and resilience of our planet is in peril. International action – not just words – must reflect this.”

Scientists' warning: a cascade of climate tipping points is possible



Guardian graphic. Source: Lenton et al, Nature, 2019

Prof Tim Lenton at the University of Exeter, the lead author of the article, said: “We might already have crossed the threshold for a cascade of interrelated tipping points. The simple version is the schoolkids [striking for climate action] are right: we are seeing potentially irreversible changes in the climate system under way, or very close.”

“As a scientist, I just want to tell it how it is,” he said. “It is not trying to be

alarmist, but trying to treat the whole climate change problem as a risk management problem. It is what I consider the common sense way.”

Phil Williamson at the University of East Anglia, who did not contribute to the article, said: “The prognosis by Tim Lenton and colleagues is, unfortunately, fully plausible: that we might have already lost control of the Earth’s climate.”

The new article comes as the **UN warns action is very far** from stopping global temperature rise, with the **world currently on track for 3C-4C**. The commentary lists nine tipping points that may have been activated.



The scientists report that 17% of the Amazon rainforest has been lost since 1970. Photograph: Léo Corrêa/AP

“We have this alarming evidence that part of the **west Antarctic ice sheet may be in irreversible retreat**,” said Lenton. “All the signals are that it is.” A similar situation appears to be occurring at the Wilkes basin in **east Antarctica**. The collapse of these ice sheets would eventually raise sea level by many metres.

The massive **Greenland ice sheet was melting at an accelerating rate**, the scientists said, while **Arctic sea ice is shrinking fast**. “Permafrost across the Arctic is beginning to irreversibly thaw and release carbon dioxide and methane,” they said.

The Gulf Stream current in the Atlantic, which warms Europe, has also **slowed by 15% since the mid-20th century**. “That is just about in the range of natural variability, but it is also hard to rule out that it is part of a longer downturn,”

Lenton said.

The scientists report that 17% of the Amazon rainforest has been lost since 1970. The tipping point, where loss of forest leads to it drying out, could lie in the range 20%-40%, they said. In temperate forests, especially in North America, heating has triggered more fires and pest outbreaks, potentially turning some regions from a sink for carbon to a source. In the tropics, **corals are predicted to be wiped out by 2C** of heating.

A cascade of tipping points could occur because, for example, the melting of Arctic sea ice amplifies heating by exposing dark ocean that absorbs more sunlight. That may increase the melting of Greenland ice and permafrost areas. “Multiple risks can interact, with one change reinforcing another, and with warming of just a degree or two sufficient to result in dramatic cascading effects,” said Williamson.

Prof Martin Siebert, at Imperial College London, said: “The new work is valuable. They are being a little speculative, but maybe you need to be.” He pointed out that the extremely rapid rate at which **CO₂ was being pumped into the atmosphere** was unlikely to have ever occurred on Earth before. “It may mean that tipping points can occur in unexpected ways as there is no geological precedent for this rate of CO₂ change.”

The article reports that preliminary results from the latest climate models suggest global heating will be greater than expected, increasing the risk of tipping points. Prof Piers Forster, at the University of Leeds, disagreed on that point. However, he added: “I completely endorse their call for action. Although possibly low probability, the risks they identify are real.”

Lenton said action would still have real benefits, by slowing the impacts and giving more time for people to adapt. He said: “This article is not meant to be a counsel of despair. If we want to avoid the worst of these bad climate tipping points, we need to activate some positive social and economic tipping points [such as renewable energy] towards what should ultimately be a happier, flourishing, sustainable future for the generations to come.”

Domino-effect of climate events could move Earth into a ‘hothouse’ state

This article is more than **1 year old**

Leading scientists warn that passing such a point would make efforts to reduce emissions increasingly futile

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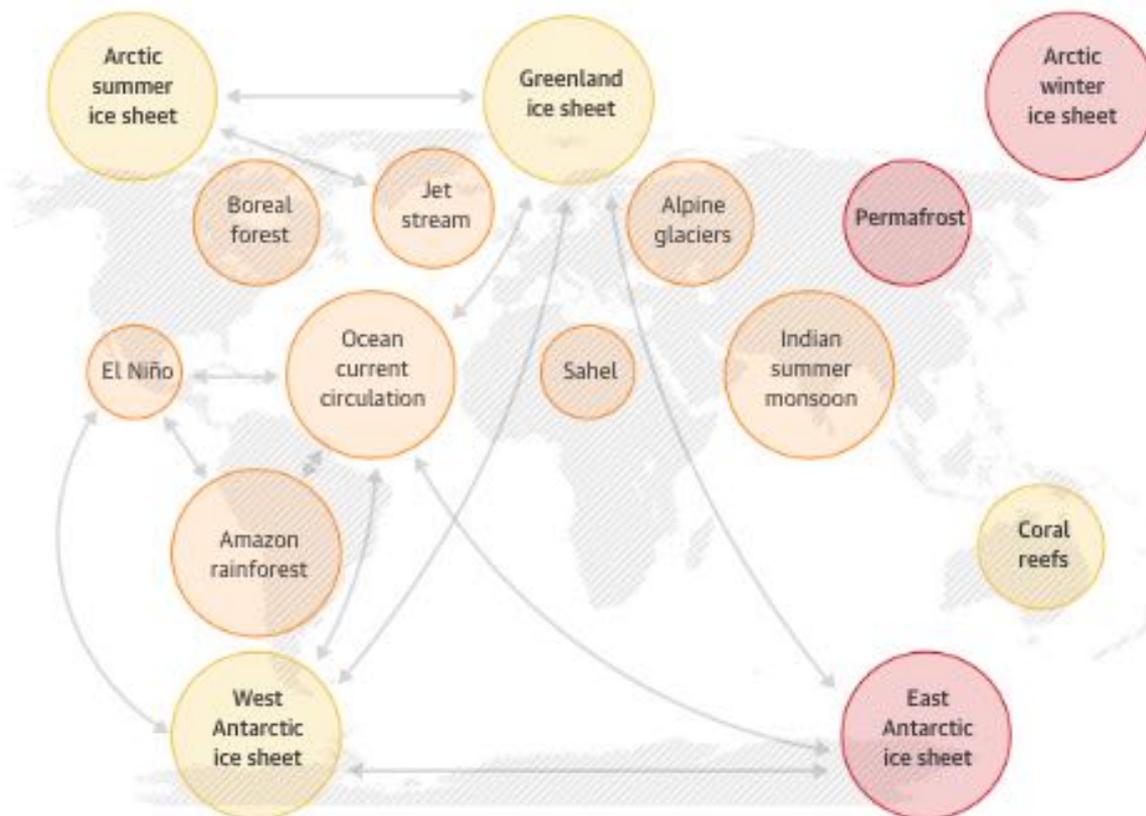
Polar bears on sea ice: the loss of the Greenland ice sheet could disrupt the Gulf Stream, which would in turn raise sea levels and accelerate Antarctic ice loss. Photograph: Paul Goldstein/Cover Images

A domino-like cascade of melting ice, warming seas, shifting currents and dying forests could tilt the Earth into a “hothouse” state beyond which human efforts to reduce emissions will be increasingly futile, a group of leading climate scientists has warned.

This grim prospect is sketched out in a journal paper that considers the combined consequences of 10 climate change processes, including the release of methane trapped in Siberian permafrost and the impact of melting ice in Greenland on the Antarctic.

Climate cascade: feedback loops could amplify one another, pushing Earth towards 'hothouse' state, warn scientists

Increase in global average surface temperatures, C ● 1 to 2.9 ● 3 to 4.9 ● Above 5



Guardian graphic. Source: Stockholm Resilience Centre

The authors of the essay, published in *Proceedings of the National Academy of Sciences*, stress their analysis is not conclusive, but warn the Paris commitment to keep warming at 2C above pre-industrial levels may not be enough to “park” the planet’s climate at a stable temperature.

They warn that the hothouse trajectory “would almost certainly flood deltaic environments, increase the risk of damage from coastal storms, and eliminate coral reefs (and all of the benefits that they provide for societies) by the end of this century or earlier.”

Fifty years ago, this would be dismissed as alarmist, but now scientists have become really worried
Johan Rockström, executive director, Stockholm Resilience Centre

“I do hope we are wrong, but as scientists we have a responsibility to explore whether this is real,” said Johan Rockström, executive director of the Stockholm

Resilience Centre. “We need to know now. It’s so urgent. This is one of the most existential questions in science.”

Rockström and his co-authors are among the world’s leading authorities on positive feedback loops, by which warming temperatures release new sources of greenhouse gases or destroy the Earth’s ability to absorb carbon or reflect heat.

Their new paper asks whether the planet’s temperature can stabilise at 2C or whether it will gravitate towards a more extreme state. The authors attempt to assess whether warming can be halted or whether it will tip towards a “hothouse” world that is 4C warmer than pre-industrial times and far less supportive of human life.

Katherine Richardson from the University of Copenhagen, one of the authors, said the paper showed that climate action was not just a case of turning the knob on emissions, but of understanding how various factors interact at a global level.

“We note that the Earth has never in its history had a quasi-stable state that is around 2C warmer than the preindustrial and suggest that there is substantial risk that the system, itself, will ‘want’ to continue warming because of all of these other processes – even if we stop emissions,” she said. “This implies not only reducing emissions but much more.”

New feedback loops are still being discovered. [A separate paper published in PNAS reveals](#) that increased rainfall – a symptom of climate change in some regions - is making it harder for forest soils to trap greenhouse gases such as methane.

Previous studies have shown that weakening carbon sinks will add 0.25C, forest dieback will add 0.11C, permafrost thaw will add 0.9C and increased bacterial respiration will add 0.02C. The authors of the new paper also look at the loss of methane hydrates from the ocean floor and the reduction of snow and ice cover at the poles.

Rockström says there are huge gaps in data and knowledge about how one process might amplify another. Contrary to the Gaia theory, which suggests the Earth has a self-righting tendency, he says the feedbacks could push the planet to a more extreme state.

As an example, the authors say the loss of Greenland ice could disrupt the Gulf Stream ocean current, which would raise sea levels and accumulate heat in the

Southern Ocean, which would in turn accelerate ice loss from the east Antarctic. Concerns about this possibility were heightened earlier this year by reports that the Gulf Stream **was at its weakest level in 1,600 years**.

Currently, global average temperatures are just over 1C above pre-industrial levels and rising at 0.17C per decade. The Paris climate agreement set actions to keep warming limited to 1.5C-2C by the end of the century, but the authors warn more drastic action may be necessary.

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“The heatwave we now have in Europe is not something that was expected with just 1C of warming,” Rockström said. “Several positive feedback loops are already in operation, but they are still weak. We need studies to show when they might cause a runaway effect.

Another climate scientist – who was not involved in the paper – emphasised the document aimed to raise questions rather than prove a theory. “It’s rather selective, but not outlandish,” said Prof Martin Siebert, co-director of the **Grantham Institute**. “Threshold and tipping points have been discussed previously, but to state that 2C is a threshold we can’t pull back from is new, I think. I’m not sure what ‘evidence’ there is for this – or indeed whether there can be until we experience it.”

Rockström said the question needed asking. “We could end up delivering the Paris agreement and keep to 2C of warming, but then face an ugly surprise if the system starts to slip away,” he said. “We don’t say this will definitely happen. We just list all the disruptive events and come up with plausible occurrences ... 50 years ago, this would be dismissed as alarmist, but now scientists have become really worried.”

“In the context of the summer of 2018, this is definitely not a case of crying wolf, raising a false alarm: the wolves are now in sight,” said Dr Phil Williamson, a climate researcher at the University of East Anglia. “The authors argue that we need to be much more proactive in that regard, not just ending greenhouse gas emissions as rapidly as possible, but also building resilience in the context of complex Earth system processes that we might not fully understand until it is

too late.”