# We may be closer than we thought to Earth's dangerous tipping points

[Environment](https://institutions.newscientist.com/subject/environment/) 23 November 2019

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Tipping points in the global climate could happen sooner than we thought

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Earth’s climate may change far more abruptly and dramatically than we thought. Regions of the planet that are thousands of kilometres apart may influence each other, causing the global climate to lurch into a new state.

The climate is warming due to our greenhouse gas emissions. However, climatologists have long suspected that parts of the planet will change dramatically and irreversibly if they are warmed past a certain “[tipping point](https://institutions.newscientist.com/article/mg19526173-900-climate-tipping-points-loom-large/)”.

One such place is the Greenland ice sheet. Warmer temperatures are melting the ice, so the upper surface of the ice is now at a lower altitude – where the air is warmer and more melting will occur. It isn’t clear how much the climate needs to warm to trigger irreversible melting, but [one study suggested 1.6°C would be enough](https://doi.org/10.1038/nclimate1449).

That is alarming, but in recent years scientists have realised that the various [tipping elements](https://institutions.newscientist.com/article/mg24332453-300-arctic-and-amazon-climate-tipping-points-put-our-future-in-doubt/) can interact: [one tipping point could trigger another](https://institutions.newscientist.com/article/mg21729064-500-arctic-thaw-may-be-first-in-cascade-of-tipping-points/), like dominoes. For example, if the Greenland ice sheet passes its tipping point and starts melting irretrievably, it will dump cold water into the north Atlantic Ocean. This could collapse a vast ocean current called the [Atlantic Meridional Overturning Circulation](https://institutions.newscientist.com/article/mg23931890-100-extreme-heat-why-its-origins-could-lie-deep-in-the-atlantic/) (AMOC), causing rapid sea level rise along the US eastern seaboard and playing havoc with the West African monsoon.

## Premature dominoes

Now a mathematical analysis of tipping points suggests that in some cases it could be even worse than that.

Previous studies of tipping point cascades focused on [what happens when one tipping element influences another](https://doi.org/10.5194/esd-2018-26). The new study takes things a step further by calculating what can happen if two elements influence each other.

It turns out there is a nasty surprise: the two tipping elements don’t have to cross their thresholds in order to tip and start changing irreversibly. “There might be a possibility that certain feedbacks between tipping elements lead to earlier than expected tipping of the connected system,” says study co-author Jonathan Donges of the Potsdam Institute for Climate Impact Research in Germany.

The study is an abstract simulation rather than an attempt to model real-world tipping points like those that could impact the Greenland ice sheet or the AMOC. Even so, the researchers think it could be applicable to the real world. In theory, then, that could mean the Greenland ice sheet will pass its tipping point and start melting unstoppably before the global climate has even warmed by 1.6°C.

**Read more:** [**There’ll be a domino effect as we trigger ecosystem tipping points**](https://institutions.newscientist.com/article/2188965-therell-be-a-domino-effect-as-we-trigger-ecosystem-tipping-points/)

However, Donges cautions that the model used is “very stylised”. The researchers did it this way first so they could understand the processes exactly, but reality is more complicated. “What can really happen in the physical world would have to be much more constrained by data and actual process-based modelling,” he says.

Nevertheless, the analysis is “very convincing”, says Anna von der Heydt of Utrecht University in the Netherlands. She says such premature tipping could well turn out to be real, and it is important to find out.

A link between Greenland and the AMOC is plausible, says Juan Rocha at the Stockholm Resilience Centre in Sweden. “They are large, [geographically] close, and their consequences are strong enough as to affect each other.”

“We really need to step by step increase the complexity of the models,” says von der Heydt, until it is possible to simulate multiple tipping elements in full climate models. The trouble is that we aren’t yet sure of the thresholds for individual tipping elements, or the strength of the links between them. She is part of a [new project called TIPES](https://tipes.sites.ku.dk/) that aims to quantify the tipping points.

In theory, pairs of tipping elements can also inhibit one another, the study found. However, Donges says [most of the climate tipping elements aren’t so obliging](https://doi.org/10.1073/pnas.0809117106). “In the climate system, the interactions will make it more likely that tipping will occur, not less likely,” he says.

Rocha agrees: “I’m afraid that… the second scenario — where they amplify each other — is more likely to occur.”