

Atlantic current shutdown is a real danger, suggests simulation

The most detailed computer model run so far shows that melting ice sheets could cause the collapse of the major ocean current that warms Europe, but it's still unclear how likely this is to happen

By [Michael Le Page](#) on February 9, 2024



An ocean current that flows from the tropics to the North Atlantic has a big influence on Europe's climate. Jens Carsten Rosemann

Is there a serious risk of the Atlantic current that warms Europe slowing to a halt as the planet heats up? Yes, according to the most detailed computer simulation run so far – but the likelihood of this scenario is still very uncertain.

“We’ve demonstrated with our current setup that it is indeed possible,” says [René van Westen](#) at Utrecht University in the Netherlands.

At present, warm water that is extra salty due to evaporation flows north from the tropics along the surface of the Atlantic Ocean, keeping Europe much warmer than it would otherwise be. As this water cools, it sinks because its high salinity increases its density. It then flows back to the tropics and into the southern hemisphere along the ocean bottom.

This is known as the Atlantic meridional overturning circulation, or AMOC. Studies of past climate suggest that episodes of dramatic cooling around Europe during the past 100,000 years

or so are linked to a slowdown or complete shutdown of the overturning current – a [so-called tipping point](#), where small changes can make a system flip into a different state.

The cause is thought to be the melting of ice sheets. If lots of fresh water enters the North Atlantic, it reduces the salinity and thus density of surface water, meaning less of it sinks.

But modelling this has proved tricky. Most simulations of a shutdown involve adding unrealistically large quantities of fresh water all at once. And in some recent simulations with more advanced models, no shutdown has occurred, leading some to doubt whether this is a potential tipping point at all.

Now van Westen's team has done the most sophisticated simulation so far, requiring a total of six months on the Netherlands' national supercomputer, called Snellius. That was very expensive, he says.

Unlike in previous simulations, the team added fresh water gradually, rather than in one go. This produced a positive feedback that amplified the effect: as less water sank because of the reduced salinity, less salty water flowed north, reducing salinity still further.

This eventually shut down the overturning circulation, causing temperatures to rise in the southern hemisphere, but plummet in Europe. For instance, in the model, London cools by 10°C (18°F) on average and Bergen in Norway by 15°C (27°F). Other consequences include [local sea level rises in places such the US East Coast](#).

What's more, some of the changes seen in the model ahead of the collapse correspond with changes being seen in the real Atlantic in recent decades.

However, to produce this collapse, the researchers had to run the model for 2500 years. And they had to add a huge amount of freshwater – less than in previous simulations, but still around 80 times more than is currently entering the ocean [as Greenland's ice sheet melts](#). “So that is absurd and not very realistic,” says van Westen.

Moreover, the simulation didn't involve any global warming. The team now plans to rerun the simulation to include it.

“This is the most state-of-the-art model where such an experiment has been done,” says [Peter Ditlevsen](#) at the University of Copenhagen, Denmark, who was co-author of a 2023 study that forecast that [the Atlantic overturning current could collapse between 2025 and 2095](#) based on how sea surface temperatures are changing.

While the model suggests it will take a lot of fresh water and many centuries to halt the overturning circulation, there are several reasons to think climate models underestimate the risk of non-linear changes like the Atlantic tipping point, says Ditlevsen.

Climate models have to divide the world into large cubes to make computations feasible, which has a smoothing effect, he says. The models are also tuned based on how well they simulate the 20th-century climate, when there was a linear relationship between greenhouse gas emissions and the resulting changes, which might not hold true in the future.

“We should expect the models to be less sensitive than the real world,” says Ditlevsen.

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