Gulf Stream current at its weakest in 1,600 years, studies show

Warm current that has historically caused dramatic changes in climate is experiencing an unprecedented slowdown and may be less stable than thought - with potentially severe consequences

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Wed 11 Apr 2018 18.00 BST
Last modified on Wed 11 Apr 2018 23.39 BST

The warm Atlantic current linked to severe and abrupt changes in the climate in the past is now at its weakest in at least 1,600 years, new research shows. The findings, based on multiple lines of scientific evidence, throw into question previous predictions that a catastrophic collapse of the Gulf Stream would take centuries to occur.

Such a collapse would see western Europe suffer far more extreme winters, sea levels rise fast on the eastern seaboard of the US and would disrupt vital tropical rains. The new research shows the current is now 15% weaker than around 400AD, an exceptionally large deviation, and that human-caused global warming is responsible for at least a significant part of the weakening.

The current, known as the Atlantic Meridional Overturning Circulation (Amoc), carries warm water northwards towards the north pole. There it cools, becomes denser and sinks, and then flows back southwards. But global warming hampers the cooling of the water, while melting ice in the Arctic, particularly from Greenland, floods the area with less dense freshwater, weakening the Amoc current.

Scientists know that Amoc has slowed since 2004, when instruments were deployed at sea to measure it. But now two new studies have provided comprehensive ocean-based evidence that the weakening is unprecedented in at least 1,600 years, which is as far back as the new research stretches.

Ocean circulation in the Atlantic is driven by warm surface currents and cold deep-water return flows

Cold deep water
Warm surface water
Guardian graphic. Source: Nature

“Amoc is a really important part of the Earth’s climate system and it has played an important part in abrupt climate change in the past,” said Dr David Thornalley, from University College London who led one of the new studies. He said current climate models do not replicate the observed slowdown, suggesting that Amoc is less stable that thought.

During the last ice age, some big changes in Amoc led to winter temperatures changing by 5-10C in as short a time as one to three years, with major consequences for the weather over the land masses bordering the Atlantic. “The [current] climate models don’t predict [an Amoc shutdown] is going to happen in the future – the problem is how certain are we it is not going to happen? It is one of these tipping points that is relatively low probability, but high impact.”

The study by Thornalley and colleagues, published in Nature, used cores of sediments from a key site off Cape Hatteras in North Carolina to examine Amoc over the last 1600 years. Larger grains of sediment reflect faster Amoc currents and vice versa.

They also used the shells of tiny marine creatures from sites across the Atlantic to measure a characteristic pattern of temperatures that indicate the strength of Amoc. When it weakens, a large area of ocean around Iceland cools, as less warm water is brought north, and the waters off the east coast of the US get warmer.

The second study, also published in Nature, also used the characteristic pattern of temperatures, but assessed this using thermometer data collected over the last 120 years or so.

Both studies found that Amoc today is about 15% weaker than 1,600 years ago, but there were also differences in their conclusions. The first study found significant Amoc weakening after the end of the little ice age in about 1850, the result of natural climate variability, with further weakening caused later by global warming.

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The second study suggests most of the weakening came later, and can be squarely blamed on the burning of fossil fuels. Further research is now being undertaken to understand the reasons for the differences.

However, it is already clear that human-caused climate change will continue to slow Amoc, with potentially severe consequences. “If we do not rapidly stop global warming, we must expect a further long-term slowdown of the Atlantic overturning,” said Alexander Robinson, at the University of Madrid, and one of the team that conducted the second study. He warned: “We are only beginning to understand the consequences of this unprecedented process – but they might be disruptive.”

A 2004 disaster movie, The Day After Tomorrow, envisaged a rapid shutdown of Amoc and a devastating freeze. The basics of the science were portrayed correctly, said Thornalley: “Obviously it was exaggerated – the changes happened in a few days or weeks and were much more extreme. But it is true that in the past this weakening of Amoc happened very rapidly and caused big changes.”

Drastic cooling in North Atlantic beyond worst fears, scientists warn

Climatologists say Labrador Sea could cool within a decade before end of this century, leading to unprecedented disruption, reports Climate News Network

Alex Kirby *for Climate News Network, part of the Guardian Environment Network*

Fri 24 Feb 2017 14.51 GMT

Last modified on Wed 14 Feb 2018 17.02 GMT

Ice covering the ocean surface along lower Baffin Island, in the Hudson Strait and the Labrador Sea. Photograph: Kike Calvo/National Geographic Creative/Alamy Stock Photo

For thousands of years, parts of northwest Europe have enjoyed a climate about 5C warmer than many other regions on the same latitude. But new scientific analysis suggests that that could change much sooner and much faster than thought possible.

Climatologists who have looked again at the possibility of major climate change in and around the Atlantic Ocean, a persistent puzzle to researchers, now say there is an almost 50% chance that a key area of the North Atlantic could cool suddenly and rapidly, within the space of a decade, before the end of this century.

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That is a much starker prospect than even the worst-case scientific scenario proposed so far, which does not see the Atlantic ocean current shutdown happening for several hundred years at least.

A scenario even more drastic (but fortunately fictional) was the subject of the 2004 US movie The Day After Tomorrow, which portrayed the disruption of the North Atlantic's circulation leading to global cooling and a new Ice Age.

To evaluate the risk of extreme climate change, researchers from the Environnements et Paléoenvironnements Océaniques et Continentaux laboratory (CNRS/University of Bordeaux, France), and the University of Southamptondeveloped an algorithm to analyse the 40 climate models considered by the Fifth Assessment Report.

The findings by the British and French team, published in the Nature Communications journal, in sharp contrast to the IPCC, put the probability of rapid North Atlantic cooling during this century at almost an even chance – nearly 50%.

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Current climate models foresee a slowing of the meridional overturning circulation (MOC), sometimes known also as the thermohaline circulation, which is the phenomenon behind the more familiar Gulf Stream that carries warmth from Florida to European shores. If it did slow, that could lead to a dramatic, unprecedented disruption of the climate system.

In 2013, drawing on 40 climate change projections, the IPCC judged that this slowdown would occur gradually, over a long period. Its findings suggested that fast cooling of the North Atlantic during this century was unlikely.

But oceanographers from EU emBRACE had also re-examined the 40 projections by focusing on a critical spot in the northwest of the North Atlantic: the Labrador Sea.

The Labrador Sea is host to a convection system ultimately feeding into the ocean-wide MOC. The temperatures of its surface waters plummet in the winter, increasing their density and causing them to sink. This displaces deep waters, which bring their heat with them as they rise to the surface, preventing the formation of ice caps.

The algorithm developed by the Anglo-French researchers was able to detect quick sea surface temperature variations. With it they found that seven of the 40 climate models they were studying predicted a total shutdown of convection, leading to abrupt cooling of

the Labrador Sea by 2C to 3C over less than 10 years. This in turn would drastically lower North Atlantic coastal temperatures.

But because only a handful of the models supported this projection, the researchers focused on the critical parameter triggering winter convection: ocean stratification. Five of the models that included stratification predicted a rapid drop in North Atlantic temperatures.

The researchers say these projections can one day be tested against real data from the international OSnap project, whose teams will be anchoring scientific instruments within the sub-polar gyre (a gyre is any large system of circulating ocean currents).

If the predictions are borne out and the North Atlantic waters do cool rapidly over the coming years, the team says, with considerable understatement, climate change adaptation policies for regions bordering the North Atlantic will have to take account of this phenomenon.