Atlantic collapse: Q&A with scientists behind controversial study predicting a colder Europe

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Credit: AI-generated image (disclaimer)

In late July, a study published in *Nature Communications* warned that a critical ocean system that brings warm water up the North Atlantic, also known as the Atlantic Meridional Overturning Circulation (AMOC), was at risk of collapse by 2095 for want of drastic emissions cuts.

While AMOC was already known to be at its slowest in 1,600 years, the latest research ushers in a much closer time estimation for a collapse between 2025 and 2095, with a central estimate of 2057. If proven correct, this scenario could see temperatures drop by 5 to 10 degrees in Europe, with devastating consequences for life as we know it. The Conversation sat down with physicist Peter Ditlevsen and his sister, the statistician Susanne Ditlevsen, to unpack findings that have stirred controversy in some quarters.

Your study understandably attracted much media attention, with some of the coverage conflating a collapse of the Gulf Stream with a collapse of AMOC. What did you make of this at the time?

Susanne Ditlevsen: I think there are two aspects to this question. One is that the general public might confuse the Gulf stream and the AMOC and, in a certain sense, that's just wording. So there is a current that brings warm water up and this is in danger of collapsing—whether we call it the AMOC or the Gulf Stream even though the Gulf Stream is something different in a certain sense doesn't matter if it's just a question of wording.

On the other, this misunderstanding can also be very harmful because there are people who know that the Gulf Stream cannot collapse, as it is driven by wind and the rotation of the earth. So when it comes out that we have predicted that the Gulf Stream will collapse, they might be tempted to dismiss us as idiots.

Ultimately, though, we don't really care about the wording because sometimes people call it the Gulf Stream system which is the Gulf Stream and AMOC, and you can say 'Well, okay'. I think it is important to explain that we are actually talking about something different, which

we and many others do believe can collapse.

Our confidence interval—which spans 2025 to 2095—was also misrepresented. There's not the same probability across the entire interval. So we find it highly unlikely that a collapse could happen as early as 2025.

It is notoriously difficult to estimate what we call the *tails of the distribution* in statistical jargon. These are the smaller probabilities at the extremes of the distribution. However, the central estimate, situated at the mid-century, is where we believe that there is the highest risk of a collapse should we continue greenhouse gas emissions at the current rate.

Now, even if we are uncertain about our estimates, the main message from is that there is a considerable or at least underestimated risk that this collapse might happen much earlier than what was previously thought.

Let's say the AMOC collapsed in 2057. What would this look like in concrete terms in Europe?

Peter Ditlevsen: If you look at it from a climate perspective, the collapse would probably be very rapid, which means it would shut down in a number of decades.

So, it's not like you have an ice age in two weeks. The Northern Atlantic region and Europe, in particular, would cool substantially. England would probably look like Northern Canada. On top of that, we have global warming. So it's a little bit as if we're driving a car and, you know, we press the speed pedal and the brake at the same time.

The heat from the Pacific ocean that would not be transported to the

North Atlantic would end up staying in the tropics. This is part of a completely different system, namely the El Niño system, which has strong implications for the warming that we're seeing now. We currently have an El Niño building up in North Africa. I mean, in Algeria, they recently had night temperatures that did not go below 39.5 degrees.

SD: What we must bear in mind here is that whatever we discuss is highly uncertain. The extent to which temperatures will vary is highly uncertain—some say five degrees, some say 10 degrees, some say more storms etc. But I think the takeaway message is that the implications would be devastating in terms of our ability to carry on living the way we do now, and to continue having agriculture in different places. You would probably have to change everything. And there would be densely populated places where one simply cannot live.

PD: Another thing to realize is that we have a hard time coping with fast changes. Our societies have historically coped with climate change through migrations. And we know how difficult this is for societies. My big concern is that we have three billion people living in tropical regions, where you have extended periods with 39 degrees that go on to become extended periods with 42 degrees.

What were your expectations when you began this project? Did you foresee these dramatic results?

PD: So I had set out to add more weight to the Intergovernmental Panel on Climate Change's (IPCC) assessment, thanks to a robust methodology and observations I planned to then adjust. It turned out that our models situated the collapse much earlier than the IPCC's. Obviously, I would have preferred the outcome of our study was less controversial because we are of course being attacked from all sides now. But that's how science works, I guess. And this was actually also how Susanne got

deeply involved, because it really needed much better statistics that I am capable of.

SD: We also believe that this problem is so important that if we do have indications in the data for an earlier or even considerably earlier collapse than what has been what is generally believed, we do have to put it out. That does not mean that our result is cut in stone. Of course not. Because data is noisy and we have indirect measurements. And of course, for every year we get more data, we can give better estimates.

We have climate changes that have huge implications on earth and also much, much larger implications than what was predicted. Just look at the extreme weather events that we have had this summer and the new temperature records. All this is happening earlier and stronger than what was predicted.

There is indeed a pattern of climate science, in particular the IPCC, showing conservative forecasts. Take, for example, the speed at which the Arctic ice is melting by comparison to their prognosis that it was safe until at least 2050.

SD: They're always conservative results. And in that sense, you could say that this is one of the reasons also that I think it gives a little more credibility to our study because of course we did not want to go against the IPCC, but they have shown to be conservative in many aspects.

Let's try to talk about future research on this question. What fields at present are helpful to understand the effect of AMOC?

PD: Yes, so I have been involved for many years in trying to understand the past climate that we see in the paleoclimatic records. From a historic point of view, the largest enigma we had in climate science has long been why ice ages happen.

In some sense, climate change is not really, you know, a puzzle. If you look at global temperature records on the one hand, and greenhouse gas concentration records on the other, they're pretty much following each other. It's a boring job that the climate models have there.

But what we see now with more and more frequent extremes, heat waves and storms and floodings, is the possibility of actually hitting a nonlinearity, a tipping point. That's a much more challenging phenomenon to model.

How can science better grasp the implications of an AMOC tipping point?

SD: We definitely need more measurements of the AMOC. But we also have to understand that we cannot measure back in time. However, since we don't and cannot have these very, very detailed measurements from pre-industrial times, before global warming, it's also difficult to assess what the natural variability is and what the natural behavior is before global warming.

PD: In a way, when you ask what is needed, I would say it's everything. This is especially the case on the modeling side. I mean, these models would require at least in some sense to reproduce what we've seen before.

SD: Yes, and I also think that it's important to stress how our work complements the very detailed models of the IPCC. One of the reasons

why our research has been so criticized is that we don't have an explanation for the outcome we observe. We know what the driver is, but we don't have that in our model.

And that is deliberate because we cannot measure the driver in a detailed enough fashion to include it into our model. On the other hand, you could also criticize the big models that are not based on good enough or detailed enough data. There's a lot of speculation to them. I mean, there are so many variables and so many parameters. So in that sense, our method has a strength of really looking at the data, but without all the mechanisms, and then you have all the models that have all the mechanisms but do not necessarily fit to data. And that combination is extremely important and useful.

But some fields are still managing to gather data by studying past sediments, right?

PD: Yes, we do have huge sediment records. The problem is that in the case of the time scales that we're looking at, any indications of tipping points will be washed out. This is because the temporal resolution in these records simply isn't good enough.

But obviously, it would be incredible if someone came up with new types of paleo data. Every now and then, you look at stalagmites and stalactites which look like they could be used… So what we really need now is for smart young people with an open mind to come over, and try new crazy things that the old guys thought were impossible.

More information: Peter Ditlevsen et al, Warning of a forthcoming collapse of the Atlantic meridional overturning circulation, *Nature Communications* (2023). DOI: 10.1038/s41467-023-39810-w