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Ocean changes to cool Europe

By Richard Black
Environment correspondent, BBC News website

"This more or less constitutes a smoking gun"

Michael Schlesinger

Changes to ocean currents in the Atlantic may cool European weather within a few decades, scientists say.

Researchers from the UK's National Oceanography Centre say currents derived from the Gulf Stream are weakening, bringing less heat north.

Their conclusions, reported in the scientific journal Nature, are based on 50 years of Atlantic observations.

They say that European political leaders need to plan for a future which may be cooler rather than warmer.

The findings come from a British research project called Rapid, which aims to gather evidence relating to potentially fast climatic change in Europe.

Atmospheric radiator

The north Atlantic conveyor

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The key is the Gulf Stream. After it emerges from the Caribbean, it splits in two, with one part heading north-east to Europe and the other circulating back through the tropical Atlantic.

As the north-eastern branch flows, it gives off heat to the atmosphere, which in turn warms European land.

"It's like a radiator giving its heat to the atmosphere," said Harry Bryden from the National Oceanography Centre (NOC) at Britain's Southampton University.

"The heat it gives off is roughly equivalent to the output of a million power stations," he told reporters.

By the time it reaches the northern latitudes around Greenland and Iceland, the water has cooled so much that it sinks towards the ocean floor, a process known as "overturning".

This cooler water heads south, forming the return stream of a conveyor belt. The complete cycle sees warm water coming northwards on the ocean's surface, and the cold water returning hundreds or thousands of metres underwater.

The Rapid team monitored at roughly 25 degrees north

Florida-based scientists monitor the northwards-flowing Gulf Stream, and have found it has remained roughly constant over the last 50 years.

The NOC researchers concentrated on the colder water flowing south; and they found that over the last half century, these currents have changed markedly.

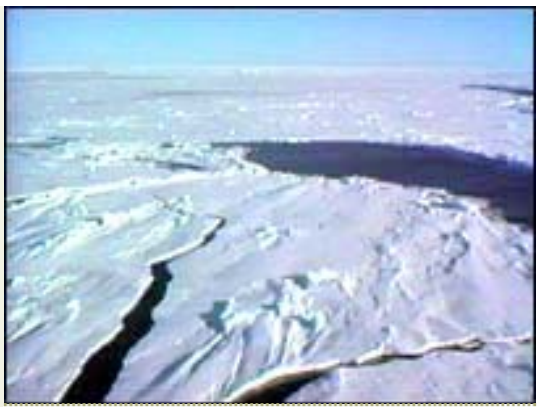
"We saw a 30% decline in the southwards flow of deep cold water," said Harry Bryden.

"And so the summary is that in 2004, we have a larger circulating current [in the tropical Atlantic] and less overturning."

And less heat, then delivered to European shores.

First evidence

Computer models of climate have regularly predicted that the north Atlantic conveyor may well reduce in intensity or even turn off altogether, a concept that was pushed beyond credence in the Hollywood blockbuster The Day After Tomorrow.



What happens is that as Arctic ice melts and Arctic rivers flow faster - trends which have both been documented - the northern oceans become less saline.

Less salinity means a lower density; the waters then cannot sink, so the conveyor weakens.

Computer models have predicted that if it turned off completely, Europe would cool by perhaps four to six degrees Celsius.

Commenting in Nature, Detlef Quadfasel from the University of Hamburg writes that the NOC experiments provide "...the first observational evidence that such a decrease of the oceanic overturning circulation is well underway."

Natural variation

The NOC researchers admit that the case is not yet proven.

The analysis involves only five sets of measurements, made in 1957, 1981, 1992 and 1998 from ships, and in 2004 from a line of research buoys tethered to the ocean floor.

Even if the trend is confirmed by further data, it could be down to natural variability rather than human-induced global temperature change.

"This issue of variability is very important," said Harry Bryden, "and we do not have any good grasp of it.

In 2004 buoys were deployed from ships onto tethers

"Models can predict it, but we think we ought to go out and

measure it."

Michael Schlesinger from the University of Illinois at Urbana-Champaign, a leading expert in models of climate and ocean circulation, believes that even with these caveats, the NOC team has probably come up with a link to human-induced climate change.

"The variability question is the right one to ask," he told the BBC News website, "but the phasing is wrong."

A decade ago Professor Schlesinger showed that the north Atlantic conveyor undergoes a natural 70-year cycle of strengthening and weakening.

"The Bryden measurements are out of phase with this cycle," he said.

"The natural cycle had a northern cooling until the mid-1970s and a warming afterwards, and here we see an apparent cooling."

He is also convinced by other details of the NOC measurements showing that the changes in the southerly underwater flow have occurred at great depths.

"The slowing down of the southward return occurs between 3,000 and 5,000m; and this more or less constitutes a smoking gun," he said.

Choosing policies

So what does all this mean for European weather? Will it necessarily get colder - or will the apparent recent trend of warmer summers continue?

> **Models can predict variability, but we think we ought to go out and measure it**
>
> Harry Bryden

"If this trend persists," said Harry Bryden, "we will see a temperature change in northern latitudes, perhaps of a degree Celsius over a couple of decades."

But climate is a complex phenomenon; other factors could conspire, even so, to produce a net warming.

"The UK government is looking, in terms of mitigating climate change and adapting to it, at a warming scenario," said Phil Newton of the UK's Natural Environment Research Council, which funds the Rapid investigators.

"You might now be asking what sort of mitigation and adaptation they should be looking for."

To answer this question, the Rapid team plans to continue their measurements in the next few years.

Their buoys remain in place, and ships can go to gather their data as often as finance allows.

The findings will have resonance beyond the shores of the UK and Europe, as extra heat left circulating around the tropical Atlantic could have major impacts on weather systems in Africa, the Caribbean and central America.

13 December 2005, 13:44 GMT

Ancient clues to ocean currents

By Jonathan Amos
BBC News science reporter, San Francisco

Foam marks points where samples have been extracted from the core. (*Image: Tom Kleindinst, Woods Hole Oceanographic Institution)*

The close link between temperatures in the North Atlantic and the strength of ocean circulation is underlined by a new analysis of sea-floor sediments.

The sediments were drilled from Blake Outer Ridge off the US east coast.

They contain traces of naturally occurring radioactive atoms in ratios that are a giveaway for the speed of ocean waters going back 60,000 years.

The work by a team from the Woods Hole Oceanographic Institution is critical to our understanding of climate change.

If human activity alters circulation speeds, as many scientists suspect may happen, it could have a dramatic impact on temperatures.

This is of particular concern in northern Europe, which benefits from the strong flow of warm waters that sweep past it from the tropics and keep winters mild.

> **“We have to get more observational data and improve our models”**
>
> Andreas Schmittner, Oregon State University

These waters eventually sink, or overturn, at high latitudes and return to the tropics as a deep, cold flow.

If this great circulation, or conveyor, slows - and there is some evidence this is happening - then European winters

should become harsher.

"Warm periods in the past are generally associated with strong ocean circulation, or overturning; and cold periods are generally associated with a weak overturning circulation," said Dr Candace Major, from Woods Hole.

"We have documented these changes in the past and associated them with abrupt climate change."

Geochemical proxy

Dr Major was speaking here at the American Geophysical Union (AGU) Fall Meeting.

The north Atlantic conveyor

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Enlarge Image

She was presenting research by her team that builds on work reported last year by another group. The 2004 results linked past temperatures, worked out from Greenland ice cores, to the strength of ocean circulation for the past 20,000 years.

The new data greatly extends that record and reinforces the significance of the relationship.

It is done by using what scientists call a geochemical proxy - an indirect record of past activity.

In the case of ocean sediments, this is a ratio of two atoms - protactinium and thorium - that appear in the water as naturally occurring uranium undergoes radioactive decay.

It happens that as sediments fall through the water, thorium tends to "stick" to them and is buried; while the not-so-sticky protactinium has a tendency to be washed out of the North

Atlantic basin.

"So, the stronger the circulation, the more the protactinium will be exported out of the North Atlantic and the less of it will be buried in the sediment," explained Dr Major.

"In the case of a sluggishly moving ocean, the more will be buried in the sediments."

Arctic melting

Dr Major displayed graphs here tracking temperature and ocean circulation from about 25,000 to 60,000 years ago that were beautifully aligned - they were virtually one for one.

The big question for science now is, which way will the graphs go in the future?

Modelling indicates global warming will slow North Atlantic circulation.

What happens is that as Arctic ice melts and Arctic rivers flow faster - trends which have both been documented - the northern ocean fills with fresh water and becomes less salty.

Less salinity means a lower density; the waters then cannot overturn, so the circulation weakens.

The previous modeling work had predicted that if this "great conveyor" turned off completely, Europe would cool by perhaps four to six degrees Celsius.

'Contradiction'

And Andreas Schmittner, of Oregon State University, came to the AGU to present the results of the very latest work in this field - a broad analysis that combined nine different computer models of future climate change.

These suggested there would not be a shutdown in the next 100 years, but rather a slowdown of about 25%.

This produced a fair amount of muttering among journalists in the hall who just this past fortnight had reported on actual measurements collected in the North Atlantic which showed there had already been a 30% weakening in strength in the

past 50 years.

"This is an apparent contradiction between the models and the observations," conceded Dr Schmittner. "We have to reconcile these differences, obviously. We have to get more observational data and improve our models."

Dr Major Commented: "It could be that the models are pointing - if you like - to average trends in ocean circulation, but that there could be significant inter-annual variability which is what the observational data has picked up; we just don't know."

Failing ocean current raises fears of mini ice age

- 18:00 30 November 2005
- NewScientist.com news service
- Fred Pearce

The ocean current that gives western Europe its relatively balmy climate is stuttering, raising fears that it might fail entirely and plunge the continent into a mini ice age.

The dramatic finding comes from a study of ocean circulation in the North Atlantic, which found a 30% reduction in the warm currents that carry water north from the Gulf Stream.

The slow-down, which has long been predicted as a possible consequence of global warming, will give renewed urgency to intergovernmental talks in Montreal, Canada, this week on a successor to the Kyoto Protocol.

Harry Bryden at the National Oceanography Centre in Southampton, UK, whose group carried out the analysis, says he is not yet sure if the change is temporary or signals a long-term trend. "We don’t want to say the circulation will shut down," he told **New Scientist**. "But we are nervous about our findings. They have come as quite a surprise."

No one-off

The North Atlantic is dominated by the Gulf Stream – currents that bring warm water north from the tropics. At around 40° north – the latitude of Portugal and New York – the current divides. Some water heads southwards in a surface current known as the subtropical gyre, while the rest continues north, leading to warming winds that raise European temperatures by 5°C to 10°C.

But when Bryden’s team measured north-south heat flow last year, using a set of instruments strung across the Atlantic from the Canary Islands to the Bahamas, they found that the division of the waters appeared to have changed since previous surveys in 1957, 1981 and 1992. From the amount of water in

the subtropical gyre and the flow southwards at depth, they calculate that the quantity of warm water flowing north had fallen by around 30%.

When Bryden added previously unanalysed data – collected in the same region by the US government's National Oceanic and Atmospheric Administration – he found a similar pattern. This suggests that his 2004 measurements are not a one-off, and that most of the slow-down happened between 1992 and 1998.

The changes are too big to be explained by chance, co-author Stuart Cunningham told **New Scientist** from a research ship off the Canary Islands, where he is collecting more data. "We think the findings are robust."

Hot and cold

But Richard Wood, chief oceanographer at the UK Met Office's Hadley Centre for climate research in Exeter, says the Southampton team's findings leave a lot unexplained. The changes are so big they should have cut oceanic heating of Europe by about one-fifth – enough to cool the British Isles by 1°C and Scandinavia by 2°C. "We haven't seen it yet," he points out.

Though unseasonably cold weather last month briefly blanketed parts of the UK in snow, average European temperatures have been rising, Wood says. Measurements of surface temperatures in the North Atlantic indicate a strong warming trend during the 1990s, which seems now to have halted.

Bryden speculates that the warming may have been part of a global temperature increase brought about by man-made greenhouse warming, and that this is now being counteracted by a decrease in the northward flow of warm water.

After warming Europe, this flow comes to a halt in the waters off Greenland, sinks to the ocean floor and returns south. The water arriving from the south is already more saline and so more dense than Arctic seas, and is made more so as ice forms.

Predicted shutdown

But Bryden's study has revealed that while one area of sinking water, on the Canadian side of Greenland, still seems to be functioning as normal, a second area on the European side has partially shut down and is sending only half as much deep water south as before. The two southward flows can be distinguished because they travel at different depths.

Nobody is clear on what has gone wrong. Suggestions for blame include the melting of sea ice or increased flow from Siberian rivers into the Arctic. Both would load fresh water into the surface ocean, making it less dense and so preventing it from sinking, which in turn would slow the flow of tropical water from the south. And either could be triggered by man-made climate change. Some climate models predict that global warming could lead to such a shutdown later this century.

The last shutdown, which prompted a temperature drop of 5°C to 10°C in

western Europe, was probably at the end of the last ice age, 12,000 years ago. There may also have been a slowing of Atlantic circulation during the Little Ice Age, which lasted sporadically from 1300 to about 1850 and created temperatures low enough to freeze the River Thames in London.

Journal reference: *Nature* (vol 438, p 655).