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Ocean currents flip out

Global warming millions of years ago put seas in a spin.

Mark Peplow

All change: the ocean currents have flipped directions in the past, and could do so again.

The circulation of the deep oceans reversed abruptly some 55 million years ago, according to a study of fossilized sea creatures. This rings alarm bells about today's climate change, because the reversal coincided with a period of global warming driven by greenhouse gases.

Deep ocean currents are intimately linked to our climate, and are driven by colder, saltier water at the poles plummeting to the bottom of the ocean. Recent studies have suggested that the circulation of the North Atlantic could be weakened by the influx of fresh water from melting polar ice. As this watery conveyor belt also brings warm water northwards from the tropics, some scientists fear that a major shift in the circulation could plunge western Europe into a deep freeze.

Although computer models can predict how ocean circulation reacts to global warming, many researchers prefer to look for similar situations in the past to see how Earth responded. One useful period to look at is the Palaeocene/Eocene Thermal Maximum (PETM) about 55 million years ago, when the average temperature of the oceans shot up by 7 or 8 °C.

Flavia Nunes and Richard Norris, oceanographers at the University of California, San Diego, have now worked out how ocean currents changed during the PETM, they report in *Nature*[1]. They have read the chemical records held in the shells of tiny fossilized deep-sea creatures called foraminifera.

Carbon capture

Using samples from the Integrated Ocean Drilling Program, Norris and Nunes studied the relative amounts of two isotopes of carbon in the shells. This acts as a snapshot of the carbon isotope ratios in the deep water that surrounded the creatures.

> **If the ocean**

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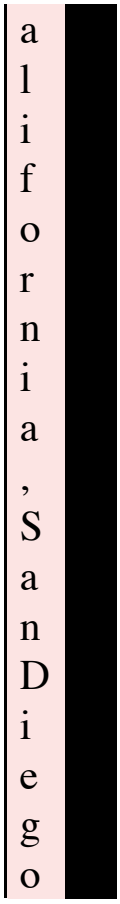
Richard Norris, oceanographer University of C



Scientists already knew that as a water mass travels along the deep section of the ocean's conveyor belt, it becomes enriched in carbon-12 compared with carbon-13. This is because it has more time to accumulate organic matter falling from dead creatures in surface waters, and these creatures tend to use more carbon-12 than carbon-13 in building their tissue.

Comparing the composition of foraminifera shells at different locations throughout the Pacific and Atlantic Oceans, the scientists found that a gradient in the ratio of carbon isotopes revealed which way the oceans' conveyor belts were turning during the PETM. They found that although the Atlantic's deep-water flow normally travels from south to north, it ran in the opposite direction during the period of global warming. Similar flips were seen in other oceans around the world.

Perhaps most remarkable is how abrupt the changes were. "The switch in circulation took just a few thousand years," says Norris. "But then it took 100,000 years to revert."

"So if the ocean flips on us we may be living with that change for a long, long time," he adds. "It's sort of frightening."

Measurements have recently shown that the Atlantic current is lessening (see 'Atlantic currents show signs of weakening'), but researchers are divided about whether modern climate change will be enough to force the current to stop or flip.

Old waters run deep

The research confirms computer models of 55-million-year-old ocean currents made by Karen Bice, an oceanographer at Woods Hole Oceanographic Institution, Massachusetts

and her colleagues2.
Although scientists have found evidence of similar links between ocean current and climate in the last 200,000 years, Bice says that the PETM is a much better analogue for the climate change we see today, because it occurred in a world that was warming gradually in response to rising greenhouse gas levels.

Norris says that they do not know the specific trigger for the circulation flip. But it seems likely that a warming world saw more evaporation from tropical seas, leading to greater rainfall at higher latitudes, explains Bice. This in turn pours fresh water into the northern oceans, weakening their currents.

"It's a good indicator of what could happen in our own future," warns Bice.

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References

1. Nunes, F. & Norris, R. D. *Nature* **439** 60–63 (2006). | Article |
2. Bice, K. L., K. L. & Marotzke, J. *Paleoceanography* **17** (2002) doi: 10.1029/2001PA000678.