NEW HOT PAPERS - 2008

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Stuart A. Cunningham talks with *ScienceWatch.com* and answers a few questions about this month's New Hot Paper in the field of Geosciences.

Article Title: Temporal variability of the Atlantic meridional overturning circulation at 26.5 degrees N
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(addresses have been truncated)

SW: Why do you think your paper is highly cited?

The Atlantic meridional overturning circulation (AMOC)—see Figure 1 below—carries 25% of the global ocean-atmosphere northward heat flux and is important for maintaining the moderate, maritime climate of the UK and western Europe. However, paleoclimate observations suggest that the circulation has, in the past, abruptly slowed in response to changes in forcing, leading to rapid cooling for the UK and Europe.

Global coupled climate models (CGCM2) reported in the Intergovernmental Planet on Climate Change (IPCC) 3rd and 4th assessment reports suggest a 25% slowing of the AMOC by 2100. Hence, it is uncertain whether there could be a rapid or prolonged slowing of the AMOC in response to global warming. Whilst *in situ* ocean observations have been able to define the average strength of the AMOC, its variability on all timescales is completely unknown.

A paper published in *Nature* in 2005 (Bryden, HL, *et al.*, "Slowing of the Atlantic Meridional Overturning Circulation at 26.5°N," *Nature* 438: 655-57, 2005) suggested—on the basis of five snapshot measurements made over five decades—that the AMOC had already slowed by 30%. The interpretation of slowing was highly controversial because of the unknown size and frequency spectrum of the AMOC variability.

Our paper has been highly cited because, for the first time, we have demonstrated that continuous *in situ* ocean observations are able to measure the AMOC on a daily basis. These observations will directly address key uncertainties in the response of Earth's climate to global warming.

The slowing of the AMOC inferred from snapshot measurements was contained within the variability of our first year of continuous observations. Although the possibility of measuring an ocean-wide circulation was controversial, we have demonstrated that it can be done. The results are acting as a stimulus for ambitious new programs in basin-wide continuous observations, and are critical for the evaluation of climate models.

Logo of the RAPID-MOC/ MOCHA project : Monitoring the Atlantic Meridional Overturning Circulation at 26.5¡N / Meridional Overturning Circulation and Heat Flux Array.

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

Our paper describes both a new methodology along with the discoveries that flowed from these new observations.

SW: Would you summarize the significance of your paper in layman's terms?

We demonstrate that it is possible to make efficient and accurate measurements of a complex circulation on an ocean-wide scale. This is leading to a new understanding of coupled ocean-atmosphere dynamics.

In particular, the data are now being used to critically evaluate the realism of coupled climate models that predict future changes in the Atlantic circulation. The system monitors interannual changes in the circulation with a resolution of 8% of the mean. This means large, abrupt changes should be readily observed. Ten years of uninterrupted measurements will ensure that any seasonal cycles are well-defined and help refine the nature of interannual variations, whether they are oscillations, trends, or shifts.

SW: How did you become involved in this research, and were there any problems along the way?

Professor Jochem Marotzke—now director of the Max Planck Institute for Meteorology, Hamburg—joined the National Oceanography Centre, Southampton in 2001. As a theorist and modeler, Professor Marotzke stimulated the observationalists to think how the problem of continuous AMOC observations could be tackled practically.

An international group was created (Figure 2), and coordinated proposals were submitted to UK and US funding agencies. The international operational team is led by Professor Bill Johns from the University of Miami, supported by the National Science Foundation; Dr. Molly O. Baringer from the Atlantic Oceanographic and Meteorological Laboratory, Miami, funded through the National Oceanographic and Atmospheric Administration; Professor Harry Bryden of the School of Ocean and Earth Sciences, University of Southampton, and Dr. Stuart Cunningham, National Oceanography Centre, Southampton, funded by the Natural Environment Research Council.

SW: Where do you see your research leading in the future?

On a personal level I wish to continue researching how the AMOC is related to climate forcing on longer timescales, so that we may better understand the role of the ocean in climate.

SW: Do you foresee any social or political implications for your research?

Knowledge on the state of the AMOC, and the ability to detect any sudden change, holds immediate political and societal benefit as the world researches plans and adapts to climate change. Abrupt changes in the AMOC have the potential to offset some, if not all, of the projected warming for the 21st century. Therefore, the ability to detect such change is vital so that the political and societal adaptive strategy is in line with (i.e., appropriate to) the level of expected warming.

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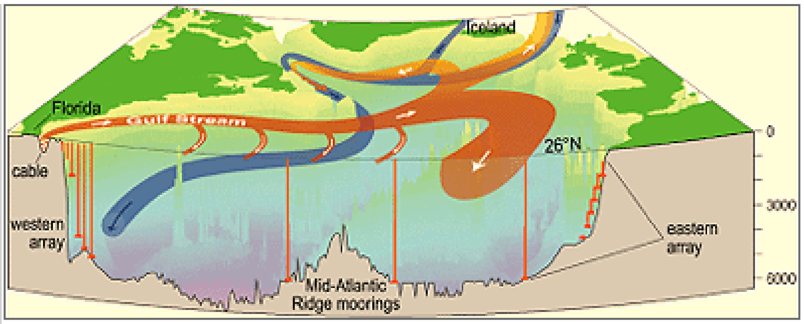
Figure 1:



Keywords: Temporal variability, Atlantic meridional overturning circulation, 26.5 degrees N, maritime climate of the UK and western Europe, paleoclimate observations, global coupled climate models, continuous in situ ocean observations, global warming, coupled ocean-atmosphere dynamics, basin-wide continuous observations, seasonal cycles, interannual variations.

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