3-23-2015

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Public Affairs, Roger Williams University

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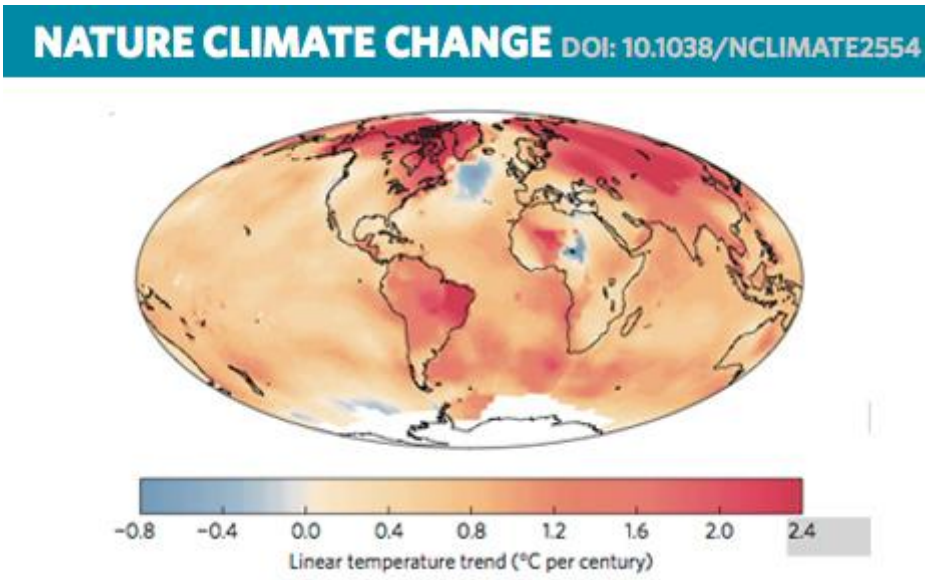
RWU faculty member Scott Rutherford among global research team to publish findings that may ultimately impact marine ecosystems, sea levels and weather systems



March 23, 2015 | Public Affairs

BRISTOL, R.I. – The Atlantic overturning is one of Earth's most important heat transport systems, pumping warm water northward and cold water southward. Also known as the Gulf Stream system, it is responsible for the mild climate in northwestern Europe. A team of researchers from Potsdam Institute for Climate Impact Research, Geological Survey of Denmark and Greenland, Pennsylvania State University and Roger Williams University has now found evidence for a slowdown of the overturning – multiple lines of observation suggest that in recent decades, the current system has been weaker than ever before in the last century, or even in the last millennium. The gradual but accelerating melting of the Greenland ice-sheet, caused by manmade global warming, is a possible major contributor to the slowdown. Further weakening could impact marine ecosystems and sea level as well as weather systems in the U.S. and Europe.

Scott Rutherford, associate professor of environmental science in RWU's Feinstein College of Arts and Sciences, is one of the researchers and co-authors of the article, "Evidence for an Exceptional 20thCentury Slowdown in Atlantic Ocean Overturning," which appears online in the journal *Nature Climate Change*. As part of the research team, Rutherford's role was to reconstruct past climate information using different types of proxy data such as tree rings, ocean or lake sediments, or cave deposits. He reconstructed the temperature in the North Atlantic subpolar gyre, the area just south

of Greenland, and compared it to the hemisphere's mean temperature – the difference gives an indication of the magnitude of Atlantic Ocean overturning. These temperature reconstructions allow the team to see how unusual the 20th Century slowdown is compared to the past 1,000 years.

"It is conspicuous that one specific area in the North Atlantic has been cooling while the rest of the world heats up," says Stefan Rahmstorf of the Potsdam Institute for Climate Impact Research, lead author of the study. Previous research had already indicated that a slowdown of the so-called Atlantic meridional overturning circulation might be to blame for this. "Now we have detected strong evidence that the global conveyor has indeed been weakening in the past hundred years, particularly since 1970," says Rahmstorf.

Because long-term direct ocean current measurements are lacking, the scientists mainly used sea-surface and atmospheric temperature data to derive information about the ocean currents, exploiting the fact that ocean currents are the leading cause of temperature variations in the subpolar north Atlantic. From so-called proxy data – gathered from ice-cores, tree-rings, coral, and ocean and lake sediments – temperatures can be reconstructed for more than a millennium back in time. The recent changes found by the team are unprecedented since the year 900 AD, strongly suggesting they are caused by man-made global warming.

"The melting Greenland ice sheet is likely disturbing the circulation"

The Atlantic overturning is driven by differences in the density of the ocean water. From the south, the warm and hence lighter water flows northwards, where the cold and thus heavier water sinks to deeper ocean layers and flows southwards. "Now freshwater coming off the melting Greenland ice sheet is likely disturbing the circulation," says co-author Jason Box of the Geological Survey of Denmark and Greenland. The freshwater is diluting the ocean water. Less saline water is less dense and has therefore less tendency to sink into the deep. "So the human-caused mass loss of the Greenland ice sheet appears to be slowing down the Atlantic overturning – and this effect might increase if temperatures are allowed to rise further," explains Box.

The observed cooling in the North Atlantic, just south of Greenland, is stronger than what most computer simulations of the climate have predicted so far. "Common climate models are underestimating the change we're facing, either because the Atlantic overturning is too stable in the models or because they don't properly account for Greenland ice sheet melt, or both," says co-author Michael Mann of Pennsylvania State University in the U.S. "That is another example where observations suggest that climate model predictions are in some respects still overly conservative when it comes to the pace at which certain aspects of climate change are proceeding."

No new ice-age – but major negative effects are possible

The cooling above the Northern Atlantic would only slightly reduce the continued warming of the continents. The scientists certainly do not expect a new ice age, thus the imagery of the 10-year-old Hollywood blockbuster 'The Day After Tomorrow' is far from reality. However, it is well established that a large, even gradual change in Atlantic ocean circulation could have major negative effects.

“If the slowdown of the Atlantic overturning continues, the impacts might be substantial,” says Rahmstorf. “Disturbing the circulation will likely have a negative effect on the ocean ecosystem, and thereby fisheries and the associated livelihoods of many people in coastal areas. A slowdown also adds to the regional sea-level rise affecting cities like New York and Boston. Finally, temperature changes in that region can also influence weather systems on both sides of the Atlantic, in North America as well as Europe.”

If the circulation weakens too much it can even break down completely – the Atlantic overturning has for long been considered a possible tipping element in the Earth System. This would mean a relatively rapid and hard-to-reverse change. The latest report by the Intergovernmental Panel on Climate Change (IPCC) estimates there to be a one-in-ten chance that this could happen as early as within this century. However, expert surveys indicate that many researchers assess the risk to be higher. The study now published by the international team of researchers around Rahmstorf provides information on which to base a new and better risk assessment.

“It’s important that we continue to follow these new patterns in the Atlantic overturning because they have a significant impact on the distribution of heat on the planet and our fundamental understanding of how the climate system works,” says Rutherford. “These changing dynamics are one of many factors that affect larger scale weather systems, potentially changing weather and precipitation patterns that we have come to expect and rely on for a variety of our global resources.”