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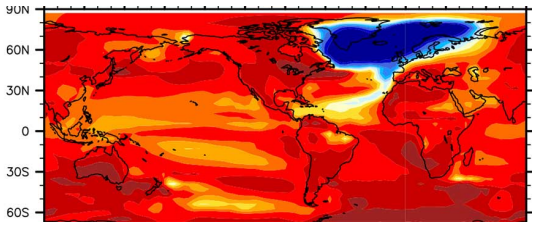
Climate Model Suggests Collapse of Atlantic Circulation Is Possible

The primary circulation pattern in the Atlantic is assumed to be stable by most scientists, but new simulation suggests collapse could happen if atmospheric greenhouse gases continue to increase

The idea of climate change causing a major ocean circulation pattern in the Atlantic Ocean to collapse with catastrophic effects has been the subject of doomsday thrillers in the movies, but in climate forecasts, it is mostly regarded as an extreme longshot.



North Atlantic Ocean cooling scenario following collapse of Atlantic Meridional Overturning Circulation

Now a new paper based on analysis done at a group of research centers including Scripps Institution of Oceanography at the University of California San Diego shows that climate models may be drastically underestimating that possibility. A bias in most climate models exaggerates the stability of the pattern, called the Atlantic meridional overturning circulation (AMOC), relative to modern climate observations. When researchers removed the bias, and re-ran simulations, the result prompted them to predict a collapse of the circulation at some point in the future, setting off large-scale cooling in the north Atlantic. The collapse would stop the AMOC, which delivers warm surface water toward Greenland then sinks as it cools and flows back toward the equator closer to the seafloor.

Wei Liu, a former Scripps postdoctoral researcher now at Yale University, Scripps climate modeler Shang-Ping Xie, and colleagues detail their findings in the paper “Overlooked possibility of a collapsed Atlantic Meridional Overturning Circulation in warming climate” appearing in the journal *Science Advances* today.

“The significance of our study is to point out a systematic bias in current climate models that hinders a correct climate projection,” said Wei. “A bias-corrected model puts the AMOC in a realistic stability regime and predicts a future AMOC collapse with prominent cooling over the northern North Atlantic and neighboring areas. Therefore, our study has enormous implications for regional and global climate change.”

In addressing future AMOC change, the paper explores an issue about which there is ongoing debate within the climate science community. The Intergovernmental Panel on Climate Change (IPCC) issues periodic reports that synthesize the latest climate change research. The panel has assumed in its two most recent reports that the AMOC is fundamentally stable and will not collapse, although it might moderately weaken as climate changes. The existence of that bias, though, is widely acknowledged by climate researchers and underscored by recent observations. Some climate modelers have proposed that it is possible that the circulation pattern is prone to collapse, capable of switching between states of multiple equilibria.

The paper uses doubling of atmospheric carbon dioxide concentration as a simple climate change scenario, and relaxes the assumption of AMOC stability. The researchers’ simulation showed that the circulation collapses 300 years after the CO_2 concentration doubles its 1990 level of roughly 355 parts per million (ppm) in air.

The effect of the collapse in the model includes a cooling of the northern Atlantic Ocean and a spread of Arctic sea ice. North Atlantic Ocean surface temperatures drop 2.4° C (4.3° F) and surface air temperatures over northwest Europe drop by as much as 7° C (12.6° F). Tropical rain belts in the Atlantic Ocean move farther southward.

The National Science Foundation, the Department of Energy, and the Ministry of Science and Technology of the People’s Republic of China funded the research. Besides Liu and Xie, report co-authors are Zhengyu Liu and Jiang Zhu of the University of Wisconsin Madison.

“It’s a very provocative idea,” said Zhengyu Liu. “For me, it’s a 180-degree turn because I had been thinking like everyone else.”

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