Circulation changes in a warmer ocean

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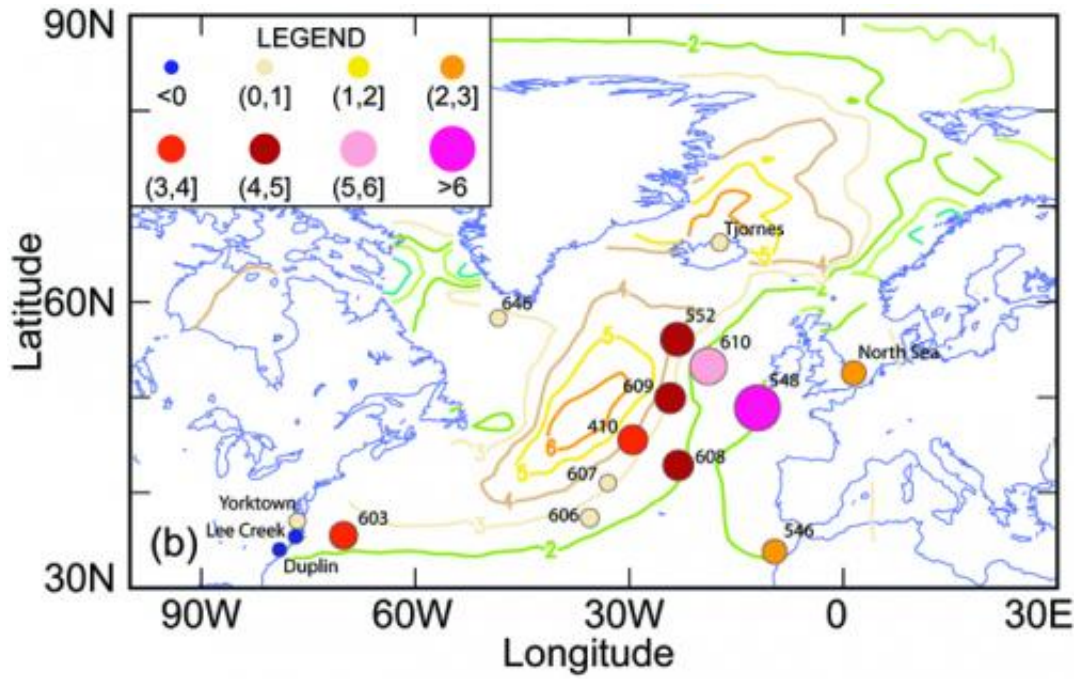

Simulated changes in sea surface temperature (oC, contours) with comparison to reconstructed changes (circles) in the North Atlantic.

Circulation changes in a warmer ocean In a new study, scientists suggest that the pattern of ocean circulation was radically altered in the past when climates were warmer.

Ancient warm periods offer useful insights into potential future warming and its impacts. The mid-Pliocene, ~3 million years ago, was a relatively recent period of global warmth that is often considered as an analog for our future.

During this warm period, unusually warm surface conditions existed in the North Atlantic, which has often been simply explained by the intensification of the existing pattern of ocean circulation. However, reproducing these changes with climate models has eluded researchers for more than a decade—suggesting either that there was something wrong with the long-standing explanation or with the models used to predict the behavior of warmer oceans.

An alternative pattern of warm ocean circulation

A team of Bergen scientists reevaluated the existing observations and used the Norwegian Earth System model (NorESM) to carry out simulations to better understand ocean circulation during the warm mid-Pliocene.

They illustrated that the largest changes occurred in the deep Southern Ocean, but not in the North Atlantic, indicating that the existing explanation was not adequate. They found that the data and simulations pointed toward an altogether different pattern of ocean circulation, with Antarctic waters playing a stronger role due to faster renewal of the deeper water masses in the Southern Ocean during the mid-Pliocene. This alternative explanation provided a solution to the long standing discrepancy between reconstructions of ocean circulation at the time and available model simulations.

North Atlantic warming

The team also addressed the unusual warmth in the North Atlantic during the warm mid-Pliocene. The observed high latitude warmth was shown not to require the intensification of todays ocean circulation and the transport of ocean heat to the north, rather it was a direct response to changes in insolation and atmospheric carbon dioxide levels at the time.

The study highlights just how differently ocean circulation was when the planet was warmer and carbon dioxide levels were high.

The study by Zhongshi Zhang, Kerim Nisancioglu and Ulysses Ninnemann from the Bjerknes Centre for Climate Research in Bergen was published on Tuesday February 19th in *Nature Communications*.

More information: Zhang, Z.-S. et al. Increased ventilation of Antarctic deep water during the warm mid-Pliocene. *Nat. Commun.* 4:1499 doi: 10.1038/ncomms2521 (2013).

Provided by University of Bergen