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Distant winds can drive massive tropical warming deep below the ocean surface

Against the backdrop of a rapidly warming climate, it's become vital to better understand the mechanisms behind heat uptake and transfer into the deep ocean. Data show that between 1970 and 2020, approximately 89% of the excess heat from climate change was absorbed by the oceans, not the atmosphere.

Instrumental records and climate simulations indicate that wind-driven ocean circulation plays a critical role in the uptake and transfer of excess heat into the ocean. However, parsing these observations has been hindered by the short duration of instrumental records and the influence of natural climate variability.

Studying ancient climate records provides an important perspective for understanding long-term response and dynamics that cannot be gleaned from short-term observations. In a new paper published in the journal Geology, Syee Weldeab, an Earth science professor at UC Santa Barbara, identifies a previously unknown mechanism that transfers heat into the deep ocean, even when surface water temperatures remain relatively stable. "The study reveals that the ocean interior acts as a vast reservoir of heat storage," said Weldeab.

Using a marine sediment sequence from the equatorial Atlantic, Weldeab reconstructed the temperature history of intermediate waters at a depth of 800 meters over the past 11,000 years. The temperature record reveals a previously unrecognized, abrupt 5° Celsius warming that began around 5,700 years ago and reached peak warming 2,500 years ago. Remarkably, this outstanding warming at depth is not mirrored by changes in the overlying surface temperatures, indicating an extratropical origin of the warming.

“I was so surprised by the finding that I put the data aside for a while,” said Weldeab. Although the temperature of the surface water in the equatorial Atlantic remained stable over the last 11,000 years, waters at a depth of 800 meters experienced large and abrupt warming.

The timing of the subsurface warming coincides with major changes to the ocean–atmosphere circulation in the Southern Hemisphere. These changes were likely driven by more solar energy reaching the surface the austral summer and include a poleward shift and strengthening of the Southern Hemisphere westerly winds.

Stronger winds enhance the subduction of relatively warm surface water, causing this water to descend to depth and propagate toward the tropical ocean interior. Weldeab proposes that the pronounced warming observed in the equatorial Atlantic intermediate waters is linked to these changes in the Southern Hemisphere’s ocean–atmosphere circulation. The hypothesis emphasizes how climate forcing at high latitudes can influence subsurface water temperature in the tropical oceans over centuries to millennia. Weldeab is currently working to map the spatial extent of this mid-Holocene warming across the major oceans.

The paleoclimatic trends Weldeab identified are ongoing; the Southern Hemisphere’s westerly winds continue to shift poleward and strengthen. “So, these findings provide an important paleoclimatic perspective,” he said. “The mechanism that we identify may intensify the impact of ongoing climate warming on the deep ocean.”

Tags
[Climate Change]
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