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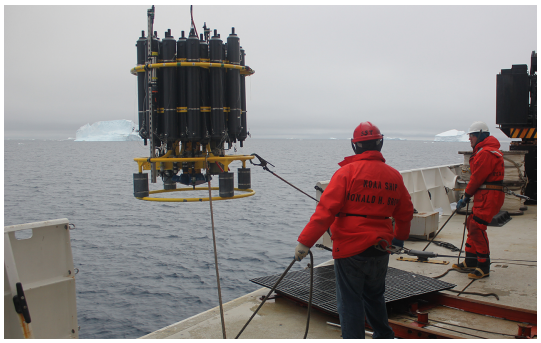
Deep Ocean Warming at an Accelerating Rate

Measurements made from ships and by Scripps-built robots both point to more heat uptake than expected

Scientists at Scripps Institution of Oceanography at the University of California San Diego and NOAA who analyzed data from deep-diving ocean robots and research cruises say that the coldest, near-bottom South Pacific waters originating from Antarctica are warming three times faster than they were in the 1990s.



Crew of NOAA Ship Ronald M. Brown deploy a CTD, an instrument that collects ocean temperature and other data

The researchers released their findings in two studies recently published online. One study led by Scripps oceanographer Sarah Purkey in the Journal of Geophysical Research compared temperature readings at depths greater than 4,000 meters (13,000 feet) made from ships between the 1990s and 2010s. The other study in the journal Geophysical Research Letters reported on data collected by 31 Deep SOLO floats in the South Pacific Ocean between 2014 and 2018. Deep SOLO floats are autonomous spherical instrument packages manufactured at Scripps that are able to descend to ocean depths up to 6,000 meters (20,000 feet) collecting information on temperature, salinity, and current strength.

The ship-based data show that deep ocean temperatures rose an average rate of 1 thousandth of a degree Celsius per year between the 1990s and the 2000s, and that rate doubled between the 2000s and the 2010s. The Deep SOLO floats reveal a tripling of the warming rate since the 1990s over the past four-plus years.

“We’ve been monitoring the deep ocean for a few decades, but this is the first time we have enough data to say that its warming rate has accelerated,” said Purkey.

Scientists had already known that the oceans are taking up about 90 percent of the excess heat energy being added to Earth's climate system by fossil fuel use and other human activities. About 10 percent of that heat is circulated to deep oceans. Purkey said she and colleagues were surprised at the amount of warming taking place at depths so far removed from the atmosphere.

As ocean waters warm, they expand, contributing to rising seas.

"Measuring the warming occurring in these deep ocean waters helps us understand one of the drivers of sea-level rise and will help to improve predictions of future sea level," said Gregory C. Johnson, a NOAA oceanographer and an author of both papers.

Both studies were supported by NOAA. Purkey's research was also partially supported by the National Science Foundation supported Global Ocean Ship-Based Hydrographic Investigations Program (GO-SHIP).

Purkey noted that in addition to warming, deep ocean water in the South Pacific was also becoming fresher. This could indicate that some of the melting from the West Antarctic Ice Sheet is flowing into the deep ocean near Antarctica or that there have been local changes in sea ice production and export in the Ross Sea. This fresher bottom water travels northward along the bottom within deep currents, and the freshening water has made it further north than had been previously observed.

Additionally, Purkey said, researchers found that the warming in the Pacific is not matched in the Atlantic Ocean, where the rate of warming has actually declined slightly. The difference is possibly owing to the fact that waters from Antarctica's Ross Sea feed the deep Pacific, while the deep South Atlantic is fed by waters originating from the relatively more protected and stable Weddell Sea on the other side of the continent.

Deep SOLO floats are a new addition to a global network of autonomous instruments known as Argo. Argo includes nearly 4,000 floats capable of reaching depths of 2,000 meters (6,500 feet) distributed throughout the world's oceans. There are currently fewer than 60 Deep SOLOs in operation but Purkey said she and colleagues are hoping the so-called Deep Argo network can eventually have the same global reach.

Besides Purkey and Johnson, contributors to the Journal of Geophysical Research paper include Scripps' Lynne Talley and colleagues from the Commonwealth Scientific and Industrial Research Organization and the Centre for Southern Hemisphere Oceans Research in Australia,

Woods Hole Oceanographic Institution in Massachusetts, Columbia University, the University of Washington, and JAMSTEC in Japan.

Johnson led the Geophysical Research Letters paper, which was co-authored by Purkey and Scripps oceanographers Nathalie Zilberman and Dean Roemmich.

– Robert Monroe

NOAA contributed to this article

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