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Is Global Heating Hiding Out in the Oceans?
Parts of Pacific Warming 15 Times Faster Than in Past 10,000 Years

A recent slowdown in global warming has led some skeptics to renew their claims that industrial carbon emissions are not causing a century-long rise in Earth's surface temperatures. But rather than letting humans off the hook, a new study in the leading journal *Science* adds support to the idea that the oceans are taking up some of the excess heat, at least for the moment. In a reconstruction of Pacific Ocean temperatures in the last 10,000 years, researchers have found that its middle depths have warmed 15 times faster in the last 60 years than they did during apparent natural warming cycles in the previous 10,000.

"We're experimenting by putting all this heat in the ocean without quite knowing how it's going to come back out and affect climate," said study coauthor Braddock Linsley, a climate scientist at Columbia University's Lamont-Doherty Earth Observatory. "It's not so much the magnitude of the change, but the rate of change."

In its latest report, released in September, the UN's Intergovernmental Panel on Climate Change (IPCC) noted the recent slowdown in the rate of global warming. While global temperatures rose by about one-fifth of a degree Fahrenheit per decade from the 1950s through 1990s, warming slowed to just half that rate after the record hot year of 1998. The IPCC has attributed the pause to natural climate fluctuations caused by volcanic eruptions, changes in solar intensity, and the movement of heat through the ocean. Many scientists note that 1998 was an exceptionally hot year even by modern standards, and so any average rise using it as a starting point would downplay the longer-term warming trend.

The IPCC scientists agree that much of the heat that humans have put into the atmosphere since the 1970s through greenhouse gas emissions probably has been absorbed by the ocean. However, the findings in *Science* put this idea into a long-term context, and suggest that the oceans may be storing even more of the effects of human emissions than scientists have so far realized. "We may have underestimated the efficiency of the oceans as a storehouse for heat and energy," said study lead author, Yair Rosenthal, a climate scientist at Rutgers University. "It may buy us some time – how much time, I don't really know. But it's not going to stop climate change."

Ocean heat is typically measured from buoys dispersed throughout the ocean, and with instruments lowered from ships, with reliable records at least in some places going back to the 1960s. To look back farther in time, scientists have developed ways to analyze the chemistry of ancient marine life to reconstruct the climates in which they lived. In a 2003 expedition to Indonesia, the researchers collected cores of sediment from the seas where water from the Pacific flows into the Indian Ocean.

By measuring the levels of magnesium to calcium in the shells of *Hyalinea balthica*, a one-celled organism buried in those sediments, the researchers estimated the temperature of the middle-depth waters where *H. Balthica* lived, from about 1,500 to 3,000 feet down. The temperature record there reflects middle-depth temperatures throughout the western Pacific, the researchers say, since the waters around Indonesia originate from the mid-depths of the North and South Pacific.

Though the climate of the last 10,000 years has been thought to be relatively stable, the researchers found that the Pacific intermediate depths have generally been cooling during that time, though with various ups and downs. From about 7,000 years ago until the start of the Medieval Warm Period in northern Europe, at about 1100, the water cooled gradually, by almost 1 degree C, or almost 4 degrees F. The rate of cooling then picked up during the so-called Little Ice Age that followed, dropping another 1 degree C, until about 1600. The authors attribute the cooling from 7,000 years ago until the Medieval Warm Period to changes in Earth's orientation toward the sun, which affected how much sunlight fell on both poles. In 1600 or so, temperatures started gradually going back up. Then, over the last 60 years, water column temperatures, averaged from the surface to 2,200 feet, increased 0.18 degrees C, or .32 degrees F. That might seem small in the scheme of things, but it's a rate of warming 15 times faster than at any period in the last 10,000 years, said Linsley.

One explanation for the recent slowdown in global warming is that a prolonged La Niña-like cooling of eastern Pacific surface waters has helped to offset the global rise in temperatures from greenhouse gases. In a study in the journal *Nature* in August, climate modelers at the Scripps Institution of Oceanography showed that La Niña cooling in the Pacific seemed to suppress global average temperatures during northern hemisphere winters but allowed temperatures to rise during northern hemisphere summers, explaining last year's record U.S. heat wave and the ongoing loss of Arctic sea ice.

When the la Niña cycle switches, and the Pacific reverts to a warmer than usual El Niño phase, global temperatures may likely shoot up again, along with the rate of warming. "With global warming you don't see a gradual warming from one year to the next," said Kevin Trenberth, a climate scientist at the National Center for Atmospheric Research in Boulder, Colo., who was not involved in the research. "It's more like a staircase. You trot along with nothing much happening for 10 years and then suddenly you have a jump and things never go back to the previous level again."

The study's long-term perspective suggests that the recent pause in global warming may just reflect random variations in heat going between atmosphere and ocean, with little long-term importance, says Drew Shindell, a climate scientist with joint appointments at Columbia's Earth Institute and the NASA Goddard Institute for Space Studies, and a lead author on the latest IPCC report. "Surface temperature is only one indicator of climate change," he said. "Looking at the total energy stored by the climate system or multiple indicators--glacier melting, water vapor in the

atmosphere, snow cover, and so on—may be more useful than looking at surface temperature alone."

The study's third author, Delia Oppo, is a climate scientist at Woods Hole Oceanographic Institution.