Oceans are warming rapidly, study says

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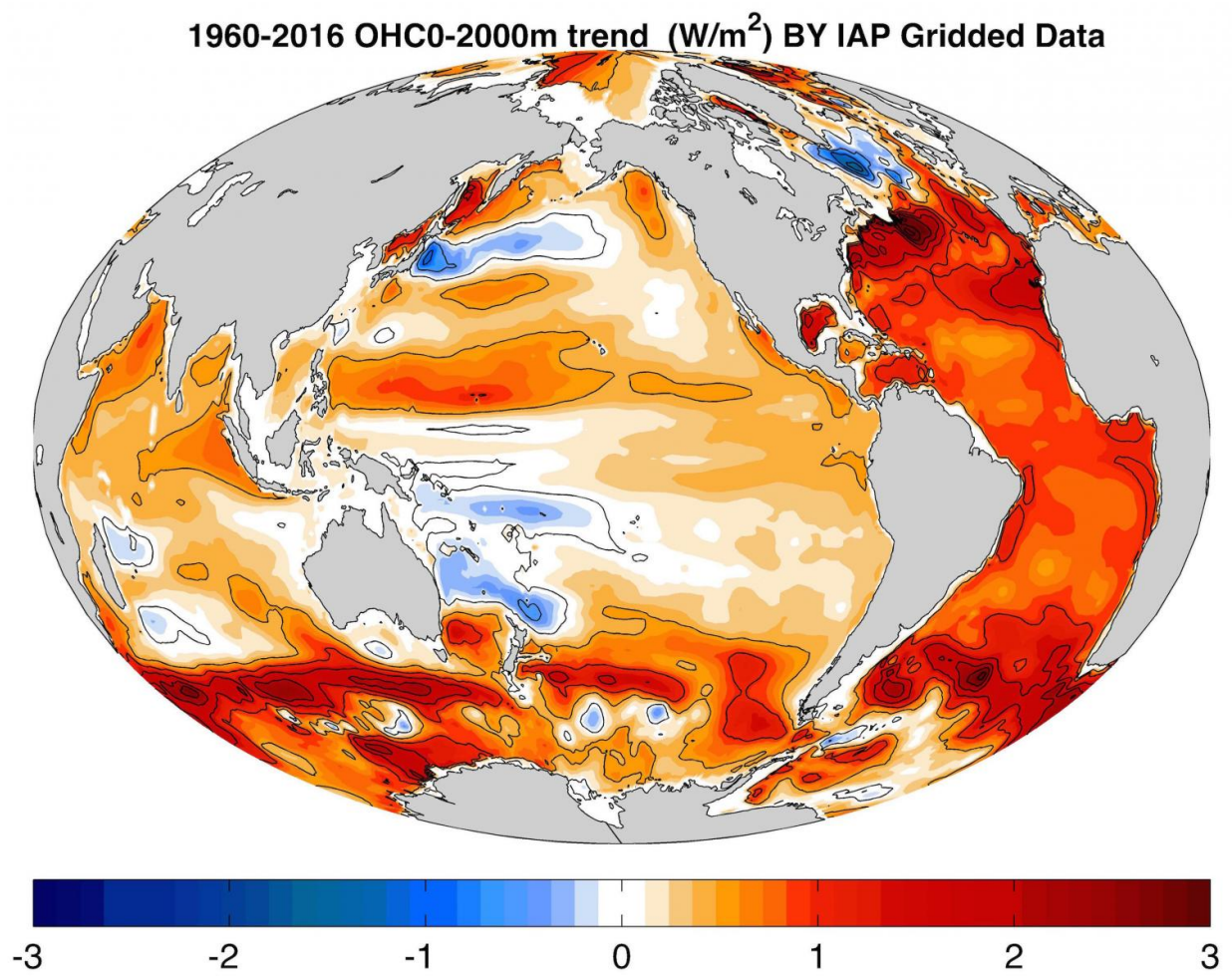

The ocean warming rate (Ocean Heat Content 0-2000m trend) from 1960 to 2016 in unit of W/m2, calculated by IAP Gridded Data. Credit: CHENG Lijing

More than 90 percent of the Earth's energy imbalance (EEI) in the

climate system is sequestered in the ocean, and consequently, the ocean heat content (OHC) is increasing. Therefore, OHC is one of the most important indicators of global warming. During the past 30 years, many independent groups have worked to estimate historical OHC changes. However, high uncertainty prevails among the published global OHC time series. For example, during the current surge of research on the so-called "hiatus" or "slowdown," many scientific studies draw different conclusions on key scientific question like where heat is redistributed in the ocean. This motivates the researchers of the current study to offer a detailed analysis of global and basin OHC changes based on multiple ocean datasets.

The new study comprehensively examined the OHC change on decadal and multi-decadal scales and at different ocean basins. Through three different objectively analyzed ocean datasets (Ishii from Japan, EN4 from Met. Office and IAP), they found that the oceans are robustly warming, regardless of which data was used. In addition, the heat among global oceans experienced a significant redistribution over the past several decades.

During the global warming slowdown period from 1998 to 2012, all of these basins had been accumulating heat, and there was no clear indication of which ocean basin dominated the global OHC change. In other words, below 100 m depth in the Atlantic and Southern Ocean, and between 100-300 m depth in the Pacific and Indian Ocean, there was statistically significant warming, and all of these regions contributed to global ocean warming. The discrepancy results from previous studies are due to the difference of depth ranges used in calculating OHC as well as the uncertainty in subsurface temperature datasets.

Why are there substantial differences among these datasets? This study shows that Ishii analysis underestimates the heating rate in the southern hemisphere in the past century. And EN4 analysis cannot correctly

reconstruct the sea surface temperature (SST) during the past 30 years and underestimates the warming rate by ~90 percent compared with an independent SST datasets such as ERSST and OISST. This indicates the Ishii and EN4 analyses may underestimate the ocean warming rate.

"In plain English, it will be important to keep high-quality temperature sensors positioned throughout the oceans so that in the future, we will be able to predict where our climate is headed," explains co-author ABRAHAM. "We say in science that a measurement not made is a measurement lost forever. And there are no more important measurements than of heating of the oceans."

More information: Gongjie Wang et al, Consensuses and discrepancies of basin-scale ocean heat content changes in different ocean analyses, *Climate Dynamics* (2017). DOI: 10.1007/s00382-017-3751-5

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