

New study confirms the oceans are warming rapidly

Although there's some uncertainty in the distribution among Earth's ocean basins, there's no question that the ocean is heating rapidly

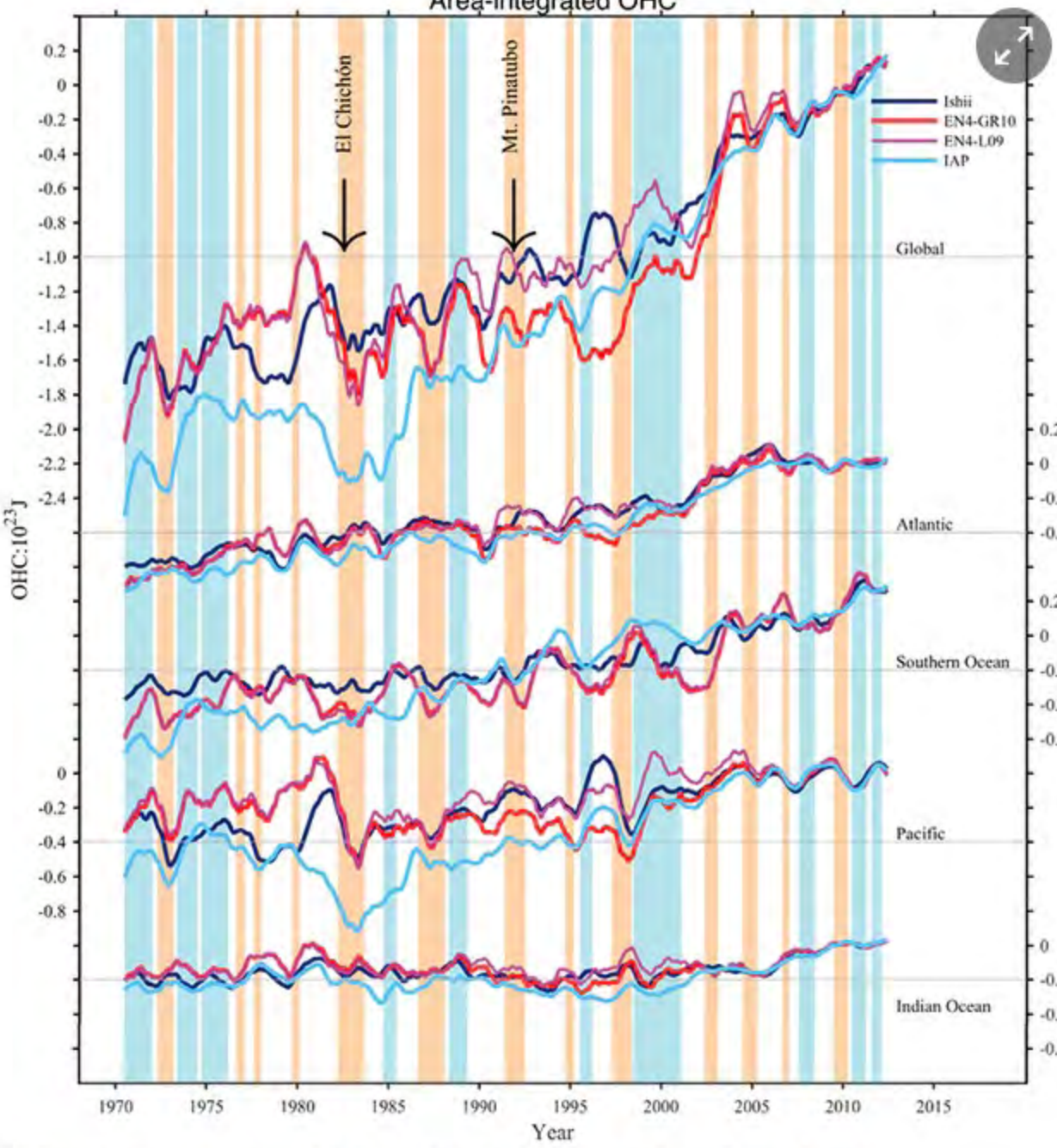


An Argo float is deployed into the ocean Photograph: CSIRO

As humans put ever more heat-trapping gases into the atmosphere, the Earth heats up. These are the basics of global warming. But where does the heat go? How much extra heat is there? And how accurate are our measurements? These are questions that climate scientists ask. If we can answer these questions, it will better help us prepare for a future with a very different climate. It will also better help us predict what that future climate will be.

The most important measurement of global warming is in the oceans. In fact, “global warming” is really “ocean warming.” If you are going to measure the changing climate of the oceans, you need to have many sensors spread out across the globe that take measurements from the ocean surface to the very depths of the waters. Importantly, you need to have measurements that span decades so a long-term trend can be established.

These difficulties are tackled by oceanographers, and a significant advancement was presented in a [paper](#) just published in the journal *Climate Dynamics*. That paper, which I was fortunate to be involved with, looked at three different ocean temperature measurements made by three different groups. We found that regardless of whose data was used or where the data was gathered, the oceans are warming.



Ocean heat content increase globally (top frame) and in four ocean basins (bottom frames). Illustration: Wang et al. (2017), *Climate Dynamics*

In the paper, we describe perhaps the three most important factors that affect ocean-temperature accuracy. First, sensors can have biases (they can be “hot” or “cold”), and these biases can change over time. An example of biases was identified in the 1940s. Then, many ocean temperature measurements were made using buckets that gathered water from ships. Sensors put into the buckets would give the water temperature. Then, a new temperature sensing approach started to come online where temperatures were measured using ship hull-based sensors at engine intake ports. It turns out that bucket measurements are slightly cooler than measurements made using hull sensors, which are closer to the engine of the ship.

During World War II, the British Navy cut back on its measurements (using buckets) and the US Navy expanded its measurements (using hull sensors); consequently, a sharp warming in oceans was seen in the data. But this warming was an artifact of the change from buckets to hull sensors. After the war, when the British fleet re-expanded its bucket measurements, the ocean temperatures seemed to fall a bit. Again, this was an artifact from the data collection. Other such biases and artifacts arose throughout the years as oceanographers have updated measurement equipment. If you want the true rate of ocean temperature change, you have to remove these biases.

Another source of uncertainty is related to the fact that we just don't have sensors at all ocean locations and at all times. Some sensors, which are dropped from cargo ships, are densely located along major shipping routes. Other sensors, dropped from research vessels, are also confined to specific locations across the globe.

Currently, we are heavily using the ARGO fleet, which contains approximately 3800 autonomous devices spread out more or less uniformly across the ocean, but these only entered service in 2005. Prior to that, temperatures measurements were not uniform in the oceans. As a consequence, scientists have to use what is called a “mapping” procedure to interpolate temperatures between temperature measurements. Sort of like filling in the gaps where no data exist. The mapping strategy used by scientists can affect the ocean temperature measurements.

Finally, temperatures are usually referenced to a baseline “climatology.” So, when we say temperatures have increased by 1 degree, it is important to say what the baseline climatology is. Have temperatures increased by 1 degree since the year 1990? Since the year 1970? Since 1900? The choice of baseline climatology really matters.

In the study, we looked at the different ways that three groups make decisions about mapping, bias, and climatology. We not only asked how much the oceans are warming, but how the warming differs for various areas (ocean basins) and various depths. We found that each ocean basin has warmed significantly. Despite this fact, there are some differences amongst the three groups. For instance, in the 300-700 meter oceans depths in the Pacific and Southern oceans, significant differences are exhibited amongst the tree groups. That said, the central fact is that regardless of how you measure, who does the measurements, when or where the measurements are taken, we are warming.

The lead author, Dr. Gongjie Wang described the importance of the study this way:

“Our study confirms again a robust global ocean warming since 1970. However, there is substantial uncertainty in decadal scale ocean heat redistribution, which explains the contradictory results related to the ocean heat changes during the “slowdown” of global warming in recent decade. Therefore, we recommend a comprehensive evaluation in the future for the existing ocean subsurface temperature datasets. Further, an improved ocean observation network is required to monitor the ocean change: extending the observations in the boundary currents systems and deep oceans (below 2000-m) besides maintaining the Argo network.”

In plain English, it will be important that we keep high-quality temperature sensors positioned throughout the oceans so in the future we will be able to predict where our climate is headed. 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.

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Dr. Gongjie Wang, lead author of research paper.

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Bojaxhiu

4h ago

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which explains the contradictory results related to the ocean heat changes during the “slowdown” of global warming in recent decade.

Interesting how the slowdown is mentioned in many peer reviewed papers but there are still people out there denying it.

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Erik Frederiksen

Bojaxhiu

3h ago

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You will notice the quote marks around slowdown.

Please point out the “slowdown” on this graph, and remember that periods of 30 years are a minimum convention for climate to weed out from noise like from strong El Niños such as 1998 and 2016 which cause spikes in surface temperature.

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<http://csas.ei.columbia.edu/files/2016/09/fig-1.-A-Better-Graph-620x442.png>

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10h ago

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It takes about a thousand years to turn the ocean over, to get the surface waters to the bottom and the bottom water to the surface. Surface waters are less dense than in the deep ocean so it takes a lot of energy to turn the ocean over.

As the surface warms faster now than the depths it gets harder to turn the ocean over, so we get a more stratified ocean.

Nutrient upwelling is already decreasing, nutrients which are needed for great fisheries like the anchoveta.

And the oxygen-rich surface waters are slowing their journey to the depths.

250 million years ago this vertical mixing turned off (1) during the Permian crises and up to 96% of all marine species and 70% of terrestrial vertebrate species became extinct.

Here's a presentation by the Scripps Oceanographic Institute marine ecologist Jeremy Jackson where he discusses this.

1. <https://www.youtube.com/watch?v=NyWHSflfiag>

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9h ago

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Nitrogen fertilizer causes such an increase in phytoplankton that a number don't get eaten, so they die of old age and sink to the bottom.

The process of decomposition uses up the oxygen, creating dead zones where everything that can't swim away dies.

In 2001 there were around 100, now about 400.

Eventually these dead zones will merge, creating a dead-zonification of the world's coastal oceans.

Eating seafood will be like gastronomic Russian Roulette, and already these dead zones are doing things like occasionally inundating hospitals in Florida with people with respiratory complaints.

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reinhardpolley

Erik Frederiksen

7h ago

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The run-off of sediments, nitrogen and other nutrients and pesticides into the oceans also damage reef ecosystems, algal blooms help feed the larvae of coral reef's most destructive pest, the crown-of-thorns Starfish.

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