

Continued record-breaking ocean temperatures seen again in 2022

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The oceans are home to millions of Earth's plants and animals. People travel on the ocean and rely on the resources it contains. Credit: Lijing Cheng

Continued record-breaking ocean temperatures with increasing stratification and changes in water salinity patterns give insight into what the future holds amidst a perpetually heating climate.

The state of our oceans can measure the world's health, and judging by the updated oceanic observations from 24 scientists across 16 institutes worldwide, we need a doctor. The three key indicators of climate change include continued historical record-breaking temperatures, all-time high levels of ocean salinity-contrast, and increased ocean stratification (separation of the water into layers) with no signs of slowing down. These indicators are leading scientists to quickly address and forecast future components of climate change to better prepare the public for an extreme climate future ahead.

A new record of 0-2000m ocean heat content (OHC) was set and recorded in 2022, with an introduction of approximately 10 Zetta joules (ZJ) more heat into the ocean than there had been in 2021. A Zetta joule is a joule (a unit measuring "work" or "heat") with 21 zeros behind it.

The results were published on January 11, 2023 in *Advances in Atmospheric Science*. It summarizes two international datasets: from the Institute of Atmospheric Physics (IAP) at the Chinese Academy of Sciences (CAS), and from the National Centers for Environmental Information (NCEI) of the National Oceanic and Atmospheric Administration (NOAA), which analyze observations of ocean heat content and their impact dating from the 1950s.

"Both IAP and NCEI data show a consistent message that upper 2000m ocean heat content hits a record high value in 2022," said Tim Boyer, a senior researcher from NCEI/NOAA.

A measure of 10 ZJ of heat is equal to approximately 100 times the world's electricity generation in 2021 (28,466 TWH), about 325 times

China's 2021 electricity production (8,537 TWH), and nearly 634 times the United States' 2021 electricity production (4,381 TWH). Ten ZJ of heat can also boil 700 million 1.5L kettles for every second in the past year.

"Global warming continues and is manifested in record ocean heat, and also in continued extremes of salinity. The latter highlight[s] that salty areas get saltier, and fresh areas get fresher, and so there is a continuing increase in intensity of the hydrological cycle," said Lijing Cheng, lead author and researcher for the IAP/CAS.

What's not hard to grasp is how that amount of heat going into the oceans will have serious consequences, and it actually will happen much faster than one would hope. The increasing saltiness and resulting stratification of the oceans can alter how heat, carbon, and oxygen are exchanged between the ocean and the atmosphere above it. This is a factor that can cause ocean deoxygenation, or loss of oxygen, within the water. Deoxygenation itself is a nightmare for not only marine life and ecosystems, but also for humans and our terrestrial ecosystems.

Reducing oceanic diversity and displacing important species can wreak havoc on fishing-dependent communities and their economies, and this can have a ripple effect on the way most people are able to interact with their environment.

Some places are already seeing the impacts of a rapidly warming ocean, and they're not exactly as expected.

"Some places are experiencing more droughts, which lead to an increased risk of wildfires, and other places are experiencing massive floods from heavy rainfall, often supported by increased evaporation from warm oceans. This contributes to changes in the hydrologic cycle and emphasizes the interactive role that oceans play," said Kevin

Trenberth, third author of the paper and researcher at both the National Center for Atmospheric Research and the University of Auckland. An increase in water temperatures and salinity directly contributes to water layering instead of mixing, and this is just part of what throws off the delicate balance between our oceans and the atmosphere.

"In the future, the group will focus on understanding the changes of the earth's major cycles and improve the future projections of earth's heat, water and carbon changes. This is the basis for human[s] to prepare for the future changes and risks," said John Abraham, Professor of University of St. Thomas, the second author of this study.

Continued tracking of these changes will give scientists an idea of what can be done preemptively to prepare for higher temperatures, extreme weather, and all other consequences that come along with warming oceans and an impacted hydrologic cycle.

"The oceans are absorbing most of the heating from human carbon emissions," said paper author Michael Mann, a professor from the University of Pennsylvania. "Until we reach net zero emissions, that heating will continue, and we'll continue to break ocean heat content records, as we did this year. Better awareness and understanding of the oceans are a basis for the actions to combat climate change."

More information: Lijing Cheng et al, *Advances in Atmospheric Sciences* (2023). [DOI: 10.1007/s00376-023-2385-2](https://doi.org/10.1007/s00376-023-2385-2)

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