

Accumulated heat in the upper ocean is at record levels again

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The Arctic sea ice extent has decreased in all seasons. Credit: Shaoqing Wang

The world's oceans are hotter than ever before, continuing their record-breaking temperature streak for the sixth straight year. The finding based on the latest data through 2021 comes at the end of the first year

of the United Nations' Decade of Ocean Science for Sustainable Development Goals, the 17 interlocked goals to maintain human societies and natural ecosystems around the globe, many of which are related to ocean health.

The most recent report, authored by 23 researchers at 14 institutes, was published on January 11, 2022 in *Advances in Atmospheric Sciences*. 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 of the National Oceanic and Atmospheric Administration (NOAA). They analyze observations of ocean heat content and their impact dating from the 1950s.

"The ocean heat content is relentlessly increasing, globally, and this is a primary indicator of human-induced climate change," said paper author Kevin Trenberth, distinguished scholar at the National Center for Atmospheric Research in Colorado. "In this most recent report, we updated observations of the ocean through 2021, while also revisiting and reprocessing earlier data."

For the last year, the researchers found that the upper 2,000 meters in all oceans absorbed 14 more Zettajoules than in 2020, equal to 145 times world electricity generation in 2020. For context, all of the energy humans use the world over in a single year is about half of a Zettajoule.

"As well as absorbing heat, currently, the ocean absorbs 20 to 30 percent of human carbon dioxide emissions, leading to [ocean acidification](#); however, ocean warming reduces the efficiency of oceanic carbon uptake and leaves more carbon dioxide in the air," said Lijing Cheng, lead paper author and associate professor with the International Center for Climate and Environmental Sciences at IAP CAS. "Monitoring and understanding the heat and carbon coupling in the future are important to track climate change mitigation goals."

The researchers also assessed the role of various natural variations, such as the warming and cooling phases known as El Niño and La Niña, which greatly affect regional temperature changes. According to Cheng, the regional analyses show that the robust and significant ocean warming since the late 1950s occurs everywhere. Nevertheless, regional marine heat waves are a consequence, with huge impacts on marine life.

"Our previous work showed that scientists need less than four years of ocean heat measurements to detect a human-induced warming signal from natural variations. This is much shorter than the nearly three decades of measurements required to detect global warming using temperatures of air near the Earth's surface. Indeed, although in the top 10 warmest years, global surface temperatures for 2021 are not the highest on record because of La Niña conditions in the tropical Pacific, among other things. Ocean heat content is one of the best indicators of climate change." said John Abraham, Professor of University of St. Thomas. During La Niña, the ocean actually takes up but buries extra heat below the surface.

"With model experiments, our study shows that the pattern of [ocean warming](#) is a result of human-related changes in atmospheric composition." Cheng said. "As oceans warm, the water expands and sea level rises. Warmer oceans also supercharge weather systems, creating more powerful storms and hurricanes, as well as increasing precipitation and flood risk."

"The oceans are absorbing most of the heating from human carbon emissions," said paper author Michael Mann, Distinguished Professor of Atmospheric Science, The Pennsylvania State University. "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, Another Record: Ocean Warming Continues through 2021 despite La Niña Conditions, *Advances in Atmospheric Sciences* (2022). [DOI: 10.1007/s00376-022-1461-3](https://doi.org/10.1007/s00376-022-1461-3)

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