Climate change rapidly warming world's lakes

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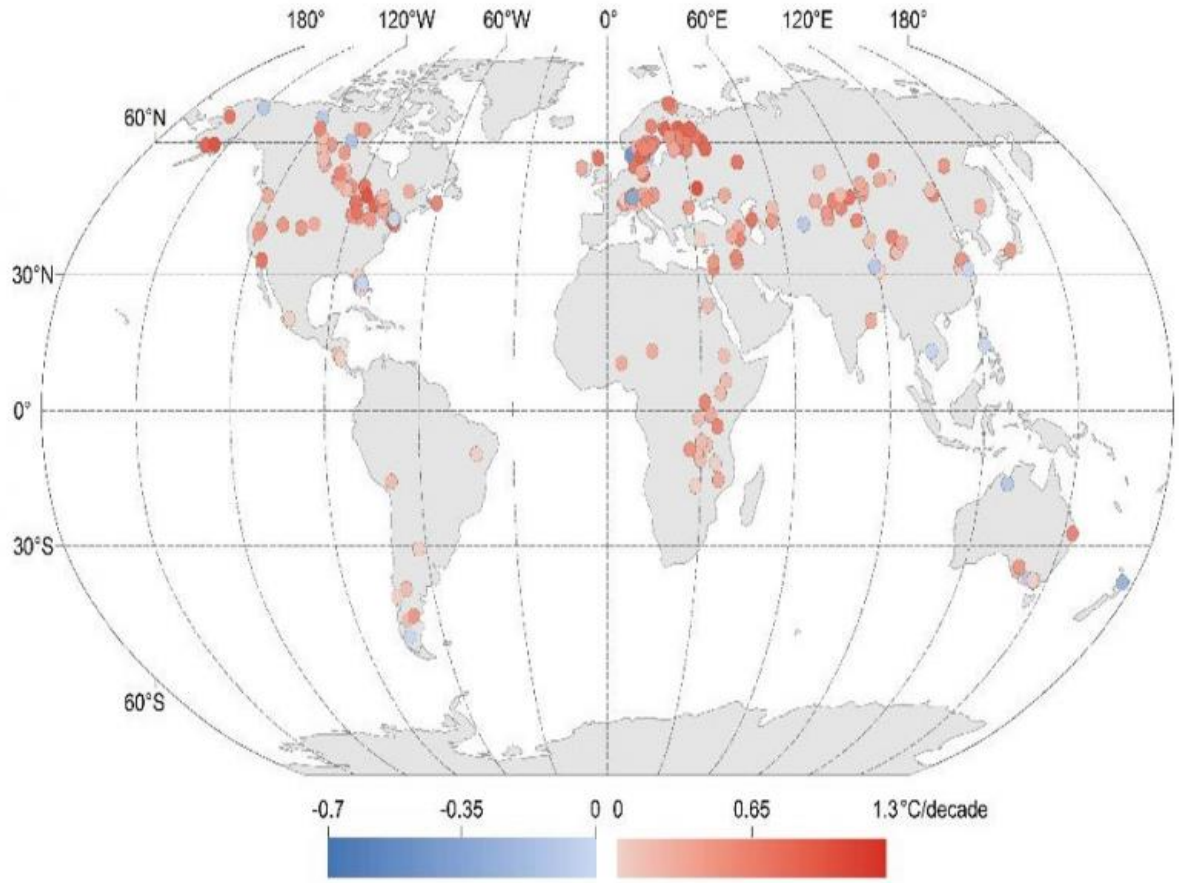


Lakes are warming at a global average of 0.61 degrees F per decade (0.34 degrees C per decade). Credit: Illinois State University/USGS/California University of Pennsylvania

Climate change is rapidly warming lakes around the world, threatening freshwater supplies and ecosystems, according to a study spanning six continents.

The study is the largest of its kind and the first to use a combination of satellite temperature data and long-term ground measurements. A total of 235 lakes, representing more than half of the world's freshwater supply, were monitored for at least 25 years. The research, published in *Geophysical Research Letters*, was announced today at the American Geophysical Union meeting.

The study, which was funded by NASA and the National Science Foundation, found lakes are warming an average of 0.61 degrees Fahrenheit (0.34 degrees Celsius) each decade. That's greater than the warming rate of either the ocean or the atmosphere, and it can have profound effects, the scientists say.

Algal blooms, which can ultimately rob water of oxygen, are projected to increase 20 percent in lakes over the next century as warming rates increase. Algal blooms that are toxic to fish and animals would increase by 5 percent. If these rates continue, emissions of methane, a greenhouse gas 25 times more powerful than carbon dioxide on 100-year time scales, will increase 4 percent over the next decade.

"Society depends on surface water for the vast majority of human uses," said co-author Stephanie Hampton, director of Washington State University's Center for Environmental Research, Education and Outreach in Pullman. "Not just for drinking water, but manufacturing, for energy production, for irrigation of our crops. Protein from freshwater fish is especially important in the developing world."

The temperature of water influences a host of its other properties critical to the health and viability of ecosystems. When temperature swings

quickly and widely from the norm, life forms in a lake can change dramatically and even disappear.

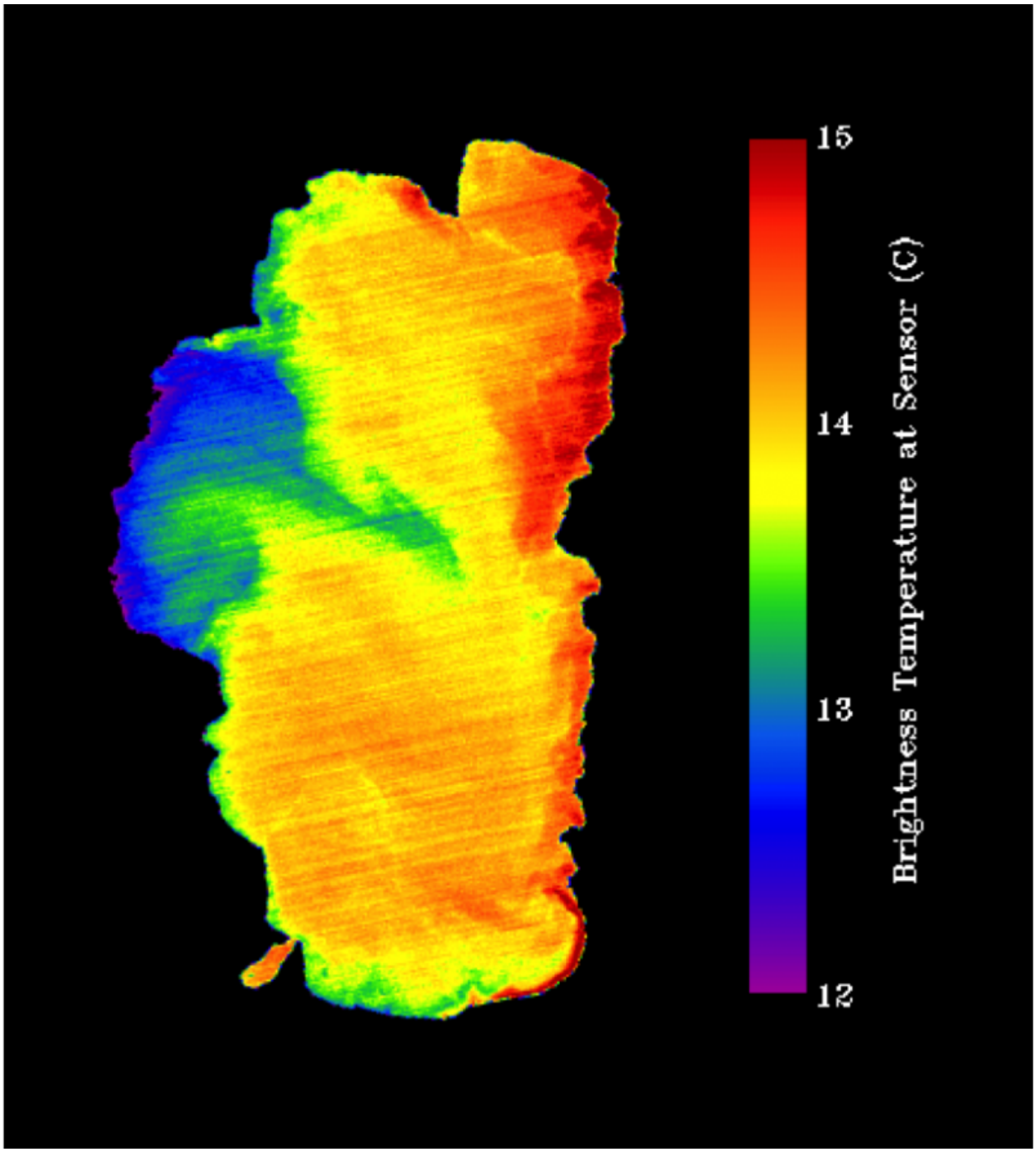
"'These results suggest that large changes in our lakes are not only unavoidable, but are probably already happening," said lead author Catherine O'Reilly, associate professor of geology at Illinois State University, Normal. Earlier research by O'Reilly has seen declining productivity in lakes with rising temperatures.

A combination of satellite data and ground measurements, such as from instrumented buoys like this one in Lake Tahoe on the California/Nevada border, were used to provide a comprehensive view of changing lake temperatures worldwide. The buoy measures the water temperature from above

and below. Credit: Limnotech

Temperature increases close to or above the average .61 degrees F rise were seen in some of the world's most popular waters, including Lake Tahoe (+.97 F by hand, +1.28 by satellite), the Dead Sea (+1.13 F), two reservoirs serving New York City, Seattle's Lake Washington (+.49 F), and the Great Lakes Huron (+1.53 F by hand, +.79 by satellite), Michigan (+.76 F by hand, +.36 by satellite), Ontario (+.59 F) and Superior (+2.09 F by hand measurement, +1.44 F by satellite).

Study co-author Simon Hook, science division manager at NASA's Jet Propulsion Laboratory in Pasadena, Calif., said satellite measurements provide a broad view of lake temperatures over the entire globe. But they only measure surface temperature, while hand measurements can detect temperature changes throughout a lake. Also, while satellite measurements go back 30 years, some lake measurements go back more than a century.



This image of Lake Tahoe, from the ASTER instrument on Terra, shows the lake's temperature variations (cold is blue, warm is red). Credit: NASA

"Combining the ground and satellite measurements provides the most comprehensive view of how lake temperatures are changing around the world," he said.

The researchers said various climate factors are associated with the warming trend. In northern climates, lakes are losing their ice cover earlier, and many areas of the world have less cloud cover, exposing their waters more to the sun's warming rays.

Previous work by Hook using satellite data indicated that many lake temperatures were warming faster than air temperature and that the greatest warming was observed at high latitudes, as seen in other climate warming studies. This new research confirmed those observations, with average warming rates of 1.3 degrees Fahrenheit (0.72 degrees Celsius) per decade at high latitudes.

Warm-water, tropical lakes may be seeing less dramatic temperature increases, but increased warming of these lakes can still have large negative impacts on fish. That can be particularly important in the African Great Lakes, where fish is an important source of food.

"We want to be careful that we don't dismiss some of these lower rates of change," said Hampton. "In warmer lakes, those temperature changes can be really important. They can be just as important as a higher rate of change in a cooler lake."

In general, the researchers write, "The pervasive and rapid warming observed here signals the urgent need to incorporate climate impacts into vulnerability assessments and adaptation efforts for lakes."

The study exemplifies the interdisciplinary work of WSU's Grand Challenges, areas of research addressing some of society's most complex issues. The study is also in keeping with the theme of the challenge

"Sustainable Resources: Food, Energy, and Water," which will develop strategies that link optimized agricultural practices, water management, and energy production

Provided by Washington State University