USF Study Shows First Direct Evidence of Ocean Acidification

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Robert Byrne, a USF seawater physical chemistry professor, samples ocean water aboard the NOAA-National Science Foundation-sponsored cruise R/V Thomas G. Thompson.

(PhysOrg.com) -- Seawater in a vast and deep section of the northeastern Pacific Ocean shows signs of increased acidity brought on by manmade carbon dioxide in the atmosphere -- a phenomenon that carries with it far-reaching ecological effects -- reports a team of researchers led by a University of South Florida College of Marine Science chemist.

The scientists, whose results are published in the American Geophysical

Union's journal Geophysical Research Letters, analyzed Pacific seawater between Oahu, Hawaii, and Kodiak, Alaska by comparing pH readings from 1991 and from 2006. This study provides the first direct measurements of basin-wide pH changes in the ocean's depths and at its surface and has produced the first direct evidence of acidification across an entire ocean basin, the investigators said.

Principal investigator Robert Byrne, a USF seawater physical chemistry professor, said the study leaves no doubt that growing CO2 levels in the atmosphere are exerting major impacts on the world's oceans.

"If this happens in a piece of ocean as big as a whole ocean basin, then this is a global phenomenon," Byrne said.

Adding carbon dioxide to seawater makes it more acidic, and each year the world's oceans absorb about one-third of the atmospheric CO2 produced by human activities.

Using pH-sensitive dyes that turn from purple to yellow in more acidic waters, the scientists were able to track changes produced by 15 years of CO2 uptake near the ocean's surface, Byrne said. In deeper waters, down to about half a mile, both anthropogenic and naturally occurring changes in CO2 and pH were seen. In the very deepest waters, no significant pH changes were seen.

The results verify earlier model projections that the oceans are becoming more acidic because of the uptake of carbon dioxide released as a result of fossil fuel burning, said Richard Feely, a member of the research team and chief scientist of the cruise and NOAA researcher from the Pacific Marine Environmental Laboratory in Seattle.

Byrne and colleagues at USF's College of Marine Science developed the methods for precise pH measurements and the project was the first time a team of researchers employed those methods in the field.

Byrne led a team of scientists that made pH measurements aboard the NOAA-National Science Foundation-sponsored cruise R/V Thomas G. Thompson in the spring of 2006 using state-of-the-art techniques developed at USF's College of Marine Science. The researchers found that upper-ocean pH had, over the preceding one-and-a-half decades, decreased by approximately 0.026 units, equivalent to an average annual pH change of -0.0017, over a large section of the northeastern Pacific. Similar recent pH trends have been found at isolated time-series stations in the North Atlantic and Pacific Oceans, and corroborating observations have also been reported by scientists who study other CO2-related substances in seawater.

"The pH decrease is direct evidence for ocean acidification of a large portion of the North Pacific Ocean," said Richard Feely. "These dramatic changes can be attributed, in most part, to anthropogenic CO2 uptake by the ocean over a 15-year period."

The implications for sea life and the world's food web are serious, Byrne said. When seawater becomes more acidic, lower concentrations of carbonate result. Because the protective shells of sea organisms are made of calcium and carbonate, more acidic waters make it more difficult for many organisms to make their shells and thrive.

That affects not only the food web, but also many important processes essential for healthy marine ecosystems, such as coral reef formation, Byrne said.

The cruise was part of a decade-long series of repeat hydrographic sections jointly funded by NOAA-Office of Global Programs (now the Climate Program Office) and NSF-Division of Ocean Sciences as part of the Climate Variability and Predictability/CO2 Repeat Hydrography

Program.

The program focuses on the need to monitor inventories of CO_2 and heat in the ocean. Earlier programs under the World Ocean Circulation Experiment and U.S. Joint Ocean Global Flux Study have provided baseline observational fields.

Scientists from 11 academic institutions and two NOAA research laboratories participated in the expedition, whose goal was to determine how the release of huge amounts of carbon dioxide from fossil-fuel burning, land-use practices, and cement production will affect the chemistry and biology of the ocean.

Over the next millennium, the global oceans are expected to absorb approximately 90 percent of the CO_2 emitted to the atmosphere, says Christopher Sabine, chief scientist for the first leg of the cruise.

"It is now established from models that there is a strong possibility that dissolved carbon dioxide in the ocean surface will double over its pre-industrial value by the middle of this century, with accompanying surface ocean pH decreases that are greater than those experienced during the transition from ice ages to warm ages," Sabine said. "The uptake of anthropogenic carbon dioxide by the ocean changes the chemistry of the oceans and can potentially have significant impacts on the biological systems in the upper oceans."

“Estimates of future atmospheric and oceanic CO_2 concentrations, based on the Intergovernmental Panel on Climate Change emission scenarios and general circulation models, indicate that by the middle of this century atmospheric CO_2 levels could reach more than 500 ppm, and near the end of the century they could be over 800 ppm. Current levels are near 390 ppm, and preindustrial levels were near 280 ppm," Feely said.

Corresponding models for the oceans indicate that surface water pH would drop approximately 0.4 pH units, and the carbonate ion concentration would decrease almost 50 percent by the end of the century. This surface ocean pH would be lower than it has been for more than 20 million years.

Byrne and many other scientists expect that even if substantial reductions are made in the pace at which humans produce carbon dioxide, ocean acidification will continue for hundreds of years to come.

“The bad news is it takes many hundreds of years for self-correcting factors to occur,” he said. “That leaves many centuries of ugly consequences.”

Provided by University of South Florida

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