New Study Finds Increasing Acidification of Pacific Ocean's Continental Shelf

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An international team of scientists surveying the waters of the continental shelf off the West Coast of North America has discovered for the first time high levels of acidified ocean water within 20 miles of the shoreline, raising concern for marine ecosystems from Canada to Mexico.

Researchers aboard the Wecoma, an Oregon State University research vessel, also discovered that this corrosive, acidified water that is being "upwelled" seasonally from the deeper ocean is probably 50 years old, suggesting that future ocean acidification levels will increase since atmospheric levels of carbon dioxide have increased rapidly over the past half century.

Results of the study were published this week in *Science Express*.

"When the upwelled water was last at the surface, it was exposed to an atmosphere with much lower CO_2 (carbon dioxide) levels than today's," pointed out Burke Hales, an associate professor in the College of Oceanic and Atmospheric Sciences at Oregon State University and an author on the Science study. "The water that will upwell off the coast in future years already is making its undersea trek toward us, with ever-increasing levels of carbon dioxide and acidity.

"The coastal ocean acidification train has left the station," Hales added, "and there not much we can do to derail it."

Scientists have become increasingly concerned about ocean acidification in recent years, as the world's oceans absorb growing levels of carbon dioxide from the atmosphere. When that CO_2 mixes into the ocean water, it forms carbonic acid that has a corrosive effect on aragonite – the calcium carbonate mineral that forms the shells of many marine creatures.

Certain species of phytoplankton and zooplankton, which are critical to the marine food web, may also be susceptible, the scientists point out, although other species of open-ocean phytoplankton have calcite shells that are not as sensitive.

"There is much research that needs to be done about the biological implications of ocean acidification," Hales said. "We now have a fairly good idea of how the chemistry works."

Increasing levels of carbon dioxide in the atmosphere are a product of the industrial revolution and consumption of fossil fuels. Fifty years ago, atmospheric CO_2 levels were roughly 310 parts per million – the highest level to that point that the Earth has experienced in the last million years, according to analyses of gas trapped in ice cores and other research.

During the past 50 years, atmospheric CO_2 levels have gradually increased to a level of about 380 parts per million.

These atmospheric CO_2 levels form the beginning baseline for carbon levels in ocean water. As water moves away from the surface toward upwelling areas, respiration increases the CO_2 and nutrient levels of the water. As that nutrient-rich water is upwelled, it triggers additional phytoplankton blooms that continue the process.

There is a strong correlation between recent hypoxia events off the Northwest coast and increasing acidification, Hales said.

"The hypoxia is caused by persistent upwelling that produces an over-abundance of phytoplankton," Hales pointed out. "When the system works, the upwelling winds subside for a day or two every couple of weeks in what we call a 'relaxation event' that allows that buildup of decomposing organic matter to be washed out to the deep ocean.

"But in recent years, especially in 2002 and 2006, there were few if any of these relaxation breaks in the upwelling and the phytoplankton blooms were enormous," Hales added. "When the material produced by these blooms decomposes, it puts more CO_2 into the system and increases the acidification."

The research team used OSU's R/V Wecoma to sample water off the coast from British Columbia to Mexico. The researchers found that the 50-year-old upwelled water had CO_2 levels of 900 to 1,000 parts per million, making it "right on the edge of solubility" for calcium carbonate-shelled aragonites, Hales said.

"If we're right on the edge now based on a starting point of 310 parts per million," Hales said, "we may have to assume that CO_2 levels will gradually increase through the next half century as the water that originally was exposed to increasing levels of atmospheric carbon dioxide is cycled through the system. Whether those elevated levels of carbon dioxide tip the scale for aragonites remains to be seen.

"But if we somehow got our atmospheric CO_2 level to immediately quit increasing," Hales added, "we'd still have increasingly acidified ocean water to contend with over the next 50 years."

Hales says it is too early to predict the biological response to increasing ocean acidification off North America's West Coast. There already is a huge seasonal variation in the ocean acidity based on phytoplankton blooms, upwelling patterns, water movement and natural terrain.

Upwelled water can be pushed all the way onto shore, he said, and barnacles, clams and other aragonites have likely already been exposed to corrosive waters for a period of time.

They may be adapting, he said, or they may already be suffering consequences that scientists have not yet determined.

“You can’t just splash some acid on a clamshell and replicate the range of conditions the Pacific Ocean presents,” Hales said. “This points out the need for cross-disciplinary research. Luckily, we have a fantastic laboratory right off the central Oregon coast that will allow us to look at the implications of ocean acidification.”

Source: Oregon State University

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