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Carbon Dioxide Extends Its Harmful Reach to Oceans

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Emissions of carbon dioxide, the main culprit linked to a warming climate, also pose potential risks to the oceans, new research suggests.

The oceans have absorbed vast amounts of carbon dioxide released in the industrial age and have measurably changed, chemically and ecologically, as a result.

In water, carbon dioxide forms carbonic acid. The buildup of the gas, mainly in the shallow layers of the oceans so far, is reducing the natural alkalinity of seawater, new studies show. In tank tests, such conditions can interfere with the reef-building ability of corals and shell production in some mollusks and tiny plankton.

The most important new research on the marine impact of carbon dioxide is described in two papers in the current issue of Science.

One study, analyzing 72,000 seawater measurements, found that the oceans absorbed about 476 billion tons of carbon dioxide from 1800 to 1994, or nearly half the total amount released in that span by worldwide burning of coal, oil and other fossil fuels, and cement production.

The second paper concluded that the gas is causing changes in water chemistry that could expose corals, mollusks and drifting plankton to conditions that dissolve calcium carbonate, the building block of reefs and shells.

This paper said that if concentrations of carbon dioxide in the atmosphere and shallow ocean layers rise as projected over the century, "the delicate balance of marine planktonic species could undergo significant shifts" with unknown repercussions.

The authors said they have already measured a substantial expansion of layers in the seas in which conditions have shifted from those that foster shell and coral growth to those that cause such materials to dissolve.

The studies are the culmination of five years of analysis of data collected through the 1990's by several world-spanning oceanographic surveys. The lead authors on both papers were Dr. Christopher L. Sabine and Dr. Richard A. Feely, oceanographers at the National Oceanic and Atmospheric Administration's Pacific Marine Environmental Laboratory in Seattle.

Dr. Sabine said the carbon dioxide measurements confirmed that the oceans have been "performing a tremendous service for humankind" by sopping up so much of the gas and thus slowing its accumulation in the atmosphere. But he and Dr. Feely said this service appeared to be coming with an unanticipated cost: potentially profound impacts on ocean chemistry and biology.

Several experts not involved with the new studies said they showed the remarkably broad influence of carbon dioxide emissions.

"These chemical changes and potential impacts on ocean biology are not something I feel comfortable contemplating," said Dr. Jorge L. Sarmiento, a professor of atmospheric and oceanic sciences at Princeton.

The recent shifts in the ocean's carbon dioxide content and chemistry have come after hundreds of thousands of years of relative stability, researchers say.

The top layers of the oceans, like the atmosphere, contained fairly unwavering concentrations of carbon dioxide for more than 400,000 years. During that span concentrations never rose above 280 parts per million.

But now concentrations are approaching 380 parts per million, and experts say it will be difficult to avoid a doubling of the pre-industrial levels by the end of the century.

Over many centuries, as slowly circulating ocean waters mix, the seas will easily be able to absorb 90 percent or more of the carbon dioxide liberated by human activities, but the impacts in the short term could still disrupt marine ecology, Dr. Feely said.

The possible marine effects of carbon dioxide emissions have become evident only in the last few years, experts said. More than 100 oceanographers and other scientists assessed the issue at a meeting in May in Paris and, in a statement last week, concluded that "effects are already occurring."

The participants said the increased absorption of acidic carbon dioxide by the seas "could have a significant negative effect on corals and other calcifying organisms, such as shellfish and some phytoplankton, disrupting marine food webs."

The changes being measured also appeared to be happening at rates far faster than natural fluctuations, they said.

"By the middle of this century, the accumulating burden of CO2 entering the ocean will lead to changes in pH or acidity of the upper layers that are three times greater in magnitude and 100 times faster than those experienced between ice ages," the participants said in the new concluding report.

The meeting was organized by a branch of the International Council for Science, a consortium of more than 100 scientific academies and unions, and the United Nations' International Oceanographic Commission.

Findings of the meeting are summarized on the Web at http://ioc.unesco.org/iocweb/co2panel/HighOceanCO2.htm.