Regardless of global warming, rising CO2 levels threaten marine life

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Like a piece of chalk dissolving in vinegar, marine life with hard shells is in danger of being dissolved by increasing acidity in the oceans.

Ocean acidity is rising as sea water absorbs more carbon dioxide released into the atmosphere from power plants and automobiles. The higher acidity threatens marine life, including corals and shellfish, which may become extinct later this century from the chemical effects of carbon dioxide, even if the planet warms less than expected.

A new study by University of Illinois atmospheric scientist Atul Jain, graduate student Long Cao and Carnegie Institution scientist Ken Caldeira suggests that future changes in ocean acidification are largely independent of climate change. The researchers report their findings in a paper accepted for publication in the journal *Geophysical Research Letters*, and posted on its Web site.

"Before our study, there was speculation in the academic community that climate change would have a big impact on ocean acidity," Jain said. "We found no such impact."

In previous studies, increasing levels of carbon dioxide in the atmosphere led to a reduction in ocean pH and carbonate ions, both of which damage marine ecosystems. What had not been studied before was how climate change, in concert with higher concentrations of carbon dioxide, would affect ocean chemistry and biology.

To investigate changes in ocean chemistry that could result from higher temperatures and carbon-dioxide concentrations, the researchers used an Earth-system model called the Integrated Science Assessment Model. Developed by Jain and his graduate students, the model includes complex physical and chemical interactions among carbon-dioxide emissions, climate change, and carbon-dioxide uptake by oceans and terrestrial ecosystems.

The ocean-surface pH has been reduced by about 0.1 during the past two centuries. Using ISAM, the researchers found ocean pH would decline a total of 0.31 by the end of this century, if carbon-dioxide emissions continue on a trajectory to ultimately stabilize at 1,000 parts per million.

During the last 200 years, the concentration of atmospheric carbon dioxide increased from about 275 parts per million to about 380 parts per million. Unchecked, it could surpass 550 parts per million by mid-century.

"As the concentration of carbon dioxide increases, ocean water will become more acidic; which is bad news for marine life," Cao said. "Fortunately, the effects of climate change will not further increase this acidity."

There are a number of effects and feedback mechanisms built into the ocean-climate system, Jain said. "Warmer water, for example, directly reduces the ocean pH due to temperature effect on the reaction rate in the carbonate system. At the same time, warmer water also absorbs less carbon dioxide, which makes the ocean less acidic. These two climate effects balance each other, which results in negligible net climate effect on ocean pH."

The addition of carbon dioxide into the oceans also affects the carbonate mineral system by decreasing the availability of carbonate ions. Calcium

carbonate is used in forming shells. With less carbonate ions available, the growth of corals and shellfish could be significantly reduced.

"In our study, the increase in ocean acidity and decrease in carbonate ions occurred regardless of the degree of temperature change associated with global warming," Jain said. "This indicates that future changes in ocean acidity caused by atmospheric carbon-dioxide concentrations are largely independent of climate change."

That's good news. The researchers' findings, however, call into question a number of engineering schemes proposed as mitigation strategies for global warming, such as lofting reflective balloons into the stratosphere or erecting huge parasols in orbit. By blocking some of the sunlight, these devices would create a cooling effect to offset the warming caused by increasing levels of greenhouse gases.

"Even if we could engineer our way out of the climate problem, we will be stuck with the ocean acidification problem," Caldeira said. "Coral reefs will go the way of the dodo unless we quickly cut carbon-dioxide emissions."

Over the next few decades, we may make the oceans more acidic than they have been for tens of millions of years, Caldeira said. And that's bad news.

Source: University of Illinois at Urbana-Champaign