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New model suggests ocean pH falling more rapidly

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(Phys.org) -- A new computer model developed in Switzerland shows that the pH of the ocean waters off the west coast of the US will fall over the next four decades faster than previously thought. The region studied is on the eastern boundary of an upwelling zone, and is important for commercial fishing and for its diversity in marine life.

An upwelling zone is one in which waters from the deep ocean well up to replace water displaced by summer surface winds, which push water away from the coast. The upwelled deep water tends to contain high concentrations of dissolved carbon dioxide (CO_2) from the respiration of microbes on the ocean floor, and this adds to the dissolved atmospheric CO_2, which is rising, producing a region of marked decreases in pH.

When CO_2 dissolves in seawater it reduces the pH by the production of carbonic acid and release of H+ ions, a process known as "acidification." According to the International Panel on Climate Change (IPCC), the mean pH of open ocean surface water is 7.9-8.3, and even with reducing pH will still be slightly basic. Even very small changes in the pH can affect marine ecosystems, but the effects are poorly known. A reduction of 0.1 in pH corresponds to a 30% increase in H+ concentration.

A reduction in ocean surface pH reduces the amount of carbonate ions in seawater, and these are used by many shell-building creatures in building their shells. A reduction in the carbonate concentration also reduces the saturation state of the mineral aragonite, which is a form of calcium carbonate also commonly used in shell building.

The computer model was developed by a team of researchers at the Swiss Federal Institute of Technology (ETH) in Zurich and concentrated on the California Current System, the upwelling region off the western coast of the USA. The aim of the research team, led by ocean biogeochemist Professor Nicolas Gruber, was to examine the effects of linking rising atmospheric levels of CO_2 and the CO_2 already dissolved in the seawater.

The model looked at two different scenarios of atmospheric CO_2 levels over the next four decades and how these emissions would add to the CO_2 levels in the upper 60 meters of seawater. The scenarios used in the modes were the Special Report on Emissions Scenarios (SRES) A2 and B1. The results showed that in both scenarios the aragonite saturation rate drops rapidly and the pH falls.

The model predicts the saturation rate of aragonite may drop to below 1 (an undersaturated state) for over half the year by 2050. When aragonite is at undersaturated levels shells made of calcium carbonate would begin to dissolve. At present, Gruber estimates undersaturated levels exist in the region around 2-4% of the time. When the saturation rate is below 1.5, as it would be for much of the year by 2050, shell-building animals such as oyster and mussel larvae and sea snails such as the tiny pteropods (sea butterfly) may find it difficult to harvest sufficient calcium carbonate to build their shells.

The paper was published in the journal *Science*.

More information: Rapid Progression of Ocean Acidification in the California Current System, *Science*, DOI: 10.1126/science.1216773

ABSTRACT

Nearshore waters of the California Current System (California CS) already today have a low carbonate saturation state, making them particularly susceptible to ocean acidification. Here, we use eddy-resolving model simulations to study the potential development of ocean acidification in this system up to 2050 under the SRES A2 and B1 scenarios. In both scenarios, the saturation state of aragonite Ωarag is projected to drop rapidly, with much of the nearshore regions developing summer-long undersaturation in the top 60 m within the next 30 years. By the year 2050, waters with Ωarag above 1.5 have largely disappeared and more than half of the waters are undersaturated year-round. Habitats along the seafloor become exposed to year-round undersaturation within the next 20 to 30 years. This has potentially major implications for the rich and diverse ecosystem that characterizes the California CS.

Press release

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