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Ocean acidification pushes coral reefs into decline

Coral reef formation is already decreasing worldwide. A new study predicts that formation will drop to 60% of its natural rate if anthropogenic CO_2 emissions continue to rise over the next century and keep acidifying the oceans.

Many marine organisms, including coral polyps, use calcium carbonate in seawater to build external skeletons and shells, a process known as calcification. However, nearly a third of the CO_2 that has been released into the atmosphere by humans since the start of the industrial revolution has been absorbed by the oceans, increasing the acidity of the water and reducing the concentration of carbonate. This process, called ocean acidification, has been shown to significantly reduce the calcification rate of such marine organisms as corals and molluscs. The extent, however, to which human activities have raised surface ocean acidity has been difficult to detect on regional scales because it varies naturally from year to year and continuous observations go back only 30 years.

The new study used a state-of-the-art computer model to simulate current ocean acidification, using historical data on CO_2 emissions (1750 to 2005), solar and volcanic activity, land use changes, aerosol concentrations and changes in the Earth's orbit. The model output was combined with existing studies to forecast the reduction in calcification over the next century (2005 to 2100) under the International Panel on Climate Change's (IPCC) A1B scenario, which predicts rapid economic growth and an equal balance between fossil fuels and clean energy sources.

The model results revealed that in major coral reef locations such as the western tropical Pacific and the Caribbean Oceans, calcification rates are presently, on average, 15% lower than they were in pre-industrial times. The model predicts a drop to 60% of pre-industrial levels by the end of the century.

Corals have evolved to tolerate naturally occurring fluctuations in acidity and calcium carbonate concentration. This natural tolerance range can be represented by the maximum and minimum concentrations found in the pre-industrial data, before human-induced impacts took effect. The researchers found that in vast areas of the world's oceans, the man-made reduction in calcium carbonate caused by ocean acidification has already exceeded the natural (pre-industrial) range of variability significantly (a factor of 2 to 10). In Micronesia, Polynesia, Melanesia and the Caribbean it has exceeded it by a factor of 20 to 30.

At the end of the last glacial period, atmospheric CO_2 concentrations rose between 17,000 to 11,000 years ago. The magnitude of this increase was similar in size to the man-made increase that occurred over the past 100 years. The scientists simulated changes in the abundance of calcium carbonate for both periods and found that the reduction over the 20 years prior to 2009 has happened at least 30 times faster than at the end of the last glacial period. In the Caribbean Ocean, the reduction in calcium carbonate has occurred up to 80 times faster.

In addition to affecting the formation of coral reefs, reduced calcification rates result in lower body mass and shell weight of coccolithophores and foraminifera. These plankton species play an important role in the food chain as well as the ocean's natural ability to absorb CO_2 from the atmosphere, mitigating anthropogenic climate change.

Further research is needed to understand how reduced calcification rates, together with additional stress factors, such as coral bleaching and coastal pollution, affect different species and the overall functioning of the ecosystem.

Source: Friedrich, T., Timmermann, A., Abe-Ouchi, A. *et al.* (2012). Detecting regional anthropogenic trends in ocean acidification against natural variability. *Nature Climate Change*. DOI: 10.1038/NCLIMATE1372.

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