# Limiting ocean acidification under global change

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Emissions of carbon dioxide are causing ocean acidification as well as global warming. Scientists have previously used computer simulations to quantify how curbing of carbon dioxide emissions would mitigate climate impacts. New computer simulations have now examined the likely effects of mitigation scenarios on ocean acidification trends. They show that both the peak year of emissions and post-peak reduction rates influence how much ocean acidity increases by 2100. Changes in ocean pH over subsequent centuries will depend on how much the rate of carbon dioxide emissions can be reduced in the longer term.

Largely as a result of human activities such as the burning of fossil fuels for energy and land-use changes such deforestation, the concentration of carbon dioxide in the atmosphere is now higher that it has been at any time over the last 800,000 years. Most scientists believe this increase in atmospheric carbon dioxide to be an important cause of global warming.

"The oceans absorb around a third of carbon dioxide emissions, which helps limit global warming, but uptake of carbon dioxide by the oceans also increases their acidity, with potentially harmful effects on calcifying organisms such as corals and the ecosystems that they support," explained Dr Toby Tyrrell of the University of Southampton's School of Ocean and Earth Science (SOES) based at the National Oceanography Centre, Southampton.

"Increased ocean acidification is also likely to affect the biogeochemistry of the oceans in ways that we do not as yet fully understand," he added.

It is widely recognised that carbon emissions need to be brought under control if the worst effects of global warming are to be avoided, but how quickly and to what extent would such mitigation measures ameliorate ocean acidification?

To address these questions, Tyrrell and his colleagues, in collaboration with researchers at the Met Office, used computer models to quantify the likely response of ocean acidification to a range of carbon dioxide emission scenarios, including aggressive mitigation. Collectively, these models take into account ocean-atmosphere interactions (such as air-sea gas exchange), climate, ocean chemistry, and the complex feedbacks between them.

"Our computer simulations allow us to predict what impact the timing and rapidity of emission reductions will have on future acidification, helping to inform policy makers" said Tyrrell.

Global mean ocean surface pH has already decreased from around 8.2 in 1750 to 8.1 today (remember than a decrease in pH corresponds to an increase in acidity). The simulations suggest that global mean ocean pH could fall to between 7.7 and 7.8 by 2100 if carbon dioxide emissions are not controlled.

"As far as we know, such a rate of change would be without precedent for millions of years, and a concern must be whether and how quickly organisms could adapt to such a rate of change after such a long period of relative stability in ocean pH," said Tyrrell.

However, if an aggressive emissions control scenario can be adopted, with emissions peaking in 2016 and reducing by 5% per year thereafter, the simulations suggest that mean surface ocean pH is unlikely to fall below 8.0 by 2100. But even that represents a large change in pH since the pre-industrial era.

A clear message from the study is that substantial emission reductions need to occur as soon as possible and that further reductions after atmospheric carbon dioxide concentration peaks will be needed if ocean pH is to be stabilized.

"Over the longer term, out to say 2500, the minimum pH will depend on just how far the annual rate of carbon dioxide emissions can be reduced to," said Tyrrell.

**More information:** Bernie, D., Lowe, J., Tyrrell, T. & Legge, O. Influence of mitigation policy on ocean acidification, Geophys. Res. Lett., 37, L15704 (2010). doi:10.1029/2010GL043181

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