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Marine oxygen holes as a consequence of oceanic acidification

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An increase of atmospheric CO_2 levels will not only drive future global mean temperatures towards values unprecedented during the whole Quaternary, but will also lead to an acidification of sea water which could harm the marine biota. Here we assess possible impacts of elevated atmospheric CO_2 concentrations on the marine biological carbon pump by utilizing a business-as-usual emission scenario of anthropogenic CO_2. A corresponding release of 4075 Petagrams of Carbon in total has been applied to simulate the current millennium by employing an Earth System Model of Intermediate Complexity (EMIC). This work is focused on studying the implications of reduced biogenic calcification caused by an increasing degree of oceanic acidification on the marine biological carbon pump.

The attenuation of biogenic calcification imposes a small negative feedback on rising atmospheric $p\mathrm{CO_2}$ levels, tending to stabilize the Earth's climate. Since mineral ballast, notably particulate $CaCO_3$, plays a dominant role in carrying organic matter through the water column, a reduction of its export fluxes weakens the strength of the biological carbon pump.

There is, however, a dramatic effect discovered in our model world with severe consequences: since organic matter is oxidized in shallow waters when mineral-ballast fluxes weaken, oxygen holes (hypoxic zones) start to expand considerably in the oceans with potentially harmful impacts on a variety of marine ecosystems. Our study indicates that unbridled ocean acidification would exacerbate the observed hypoxia trends due to various environmental factors as reported in recent empirical studies.