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TITLE: Biotic and Human Vulnerability to Projected Changes in Ocean Biogeochemistry over the 21st Century

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ABSTRACT:

Ongoing greenhouse gas emissions can modify climate processes and induce shifts in ocean temperature, pH, oxygen concentration, and productivity, which in turn could alter biological and social systems. Here, we provide a synoptic global assessment of the simultaneous changes in future ocean biogeochemical variables over marine biota and their broader implications for people. We analyzed modern Earth System Models forced by greenhouse gas concentration pathways until 2100 and showed that the entire world's ocean surface will be simultaneously impacted by varying intensities of ocean warming, acidification, oxygen depletion, or shortfalls in productivity. In contrast, only a small fraction of the world's ocean surface, mostly in polar regions, will experience increased oxygenation and productivity, while almost nowhere will there be ocean cooling or pH elevation. We compiled the global distribution of 32 marine habitats and biodiversity hotspots and found that they would all experience simultaneous exposure to changes in multiple biogeochemical variables. This superposition highlights the high risk for synergistic ecosystem responses, the suite of physiological adaptations needed to cope with future climate change, and the potential for reorganization of global biodiversity patterns. If co-occurring biogeochemical changes influence the delivery of ocean goods and services, then they could also have a considerable effect on human welfare. Approximately 470 to 870 million of the poorest people in the world rely heavily on the ocean for food, jobs, and revenues and live in countries that will be most affected by simultaneous changes in ocean biogeochemistry. These results highlight the high risk of degradation of marine ecosystems and associated human hardship expected in a future following current trends in anthropogenic greenhouse gas emissions.

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