Global warming can lead to global anoxia and mass extinctions by disrupting oxygen production in oceans

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A lot have been said about negative consequences of the global warming. However, the worst kind of catastrophe that could affect most of the living being on Earth may yet have been overlooked. We consider the effect of global warming on the coupled plankton-oxygen dynamics in the ocean. The net oxygen production by phytoplankton is known to depend on the water temperature and hence can be disrupted by warming. We address this issue theoretically by considering a novel mathematical model of the plankton-oxygen dynamics [1, 2, 3]. The model consists of a system of nonlinear ODEs in the non-spatial case and of a system of nonlinear PDEs in the corresponding spatially explicit case. We show that sustainable oxygen production by phytoplankton is only possible if the net oxygen production rate is within a certain intermediate range (i.e. not too low and not too high). This appears to be in agreement with some available field data. We show that a sufficiently large increase in the water temperature is likely to push the system out of the safe range, which results in a regime shift (bifurcation) leading to the global oxygen depletion. Since the oxygen produced in the ocean contributes about 70% to the atmospheric stock, arguably this regime shift would make the air unbreathable and hence likely result in mass mortality of animals and humans. We then discuss the temporal scale at which the oxygen depletion can occur and show that this catastrophe can be preceded by long-term transient dynamics [4]: long periods of apparently stable, "safe" system functioning which eventually experiences a fast transition to extinction. Finally, we argue that a similar type of ecological catastrophe may have happened in the past, in particular resulting in some of the mass extinction events in Earth paleohistory.

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