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Severe perturbations of the marine biosphere following the Chicxulub impact

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Among the "big five" mass-extinction events during the Phanerozoic, the end-Cretaceous extinction 66 million years ago is particularly well known because it marks the demise of the non-avian dinosaurs. Evidence for the Chicxulub impact as the primary cause of this mass extinction has been accumulating over the past four decades, but there are still many open questions regarding the detailed course of events.

Building on our earlier modelling results demonstrating strong global cooling due to sulfate aerosols formed in the wake of the Chicxulub impact (Brugger, Feulner & Petri 2017, Geophys. Res. Lett., 44:419-427), we here explore the response of the ocean in more detail. Specifically, we added a marine biogeochemistry module to a coupled atmosphere-ocean model to investigate the effects of the impact on ocean geochemistry and primary productivity.

We find that the formation of stratospheric sulfate aerosols leads to a marked decrease in annual global mean surface air temperatures by at least 26°C in the coldest year after the impact, returning to pre-impact temperatures after about one century. The strong surface cooling induces vigorous ocean mixing that leads to changes in oxygen distributions and nutrient availability. Due to the darkness, marine net primary productivity essentially shuts down in the first years after the impact. Once the light returns, however, we find a significant increase in primary productivity caused by a surge in nutrient availability, both due to upwelling in the ocean and delivery by the impactor. These strong perturbations of the marine biosphere further support the notion that the impact played a decisive role in the end-Cretaceous mass extinction.