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Modeling the impact of oceanic circulation and marine productivity on Cretaceous seafloor anoxia

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Oceanic anoxic events (OAEs) are abrupt events of widespread deposition of organic-rich sediments and extensive seafloor anoxia. Mechanisms usually invoked as drivers of oceanic anoxia are various and still debated today. They include a rise of the CO2 atmospheric level due to increased volcanic activity, a control by the paleogeography, changes in oceanic circulation or enhanced marine productivity. In order to assess the role of these mechanisms, we use an IPCC-class model, the IPSL-CM5A2 Earth System Model, which couples the atmosphere, land surface, and ocean components, this last one including sea ice, physical oceanography and marine biogeochemistry which allows to simulate oceanic oxygen.

We focus here on OAE2, which occurs during the Cretaceous at the Cenomanian-Turonian boundary (93.5 Ma), and is identified as a global event with evidence for seafloor anoxia in the Atlantic and Indian Oceans, the Southwest Tethys Sea and the Equatorial Pacific Ocean. Using a set of simulations from 115 to 70 Ma, we analyze the long-term paleogeographic control on oceanic circulation and consequences on oceanic oxygen concentration and anoxia spreading. Short-term controls such as an increase of pCO_2, nutrients, or orbital configurations are also studied with a second set of simulations with a Cenomano-Turonian (90 Ma) paleogeographic configuration. The different simulated maps of oxygen are used to study the evolution of marine productivity and oxygen minimum zones as well as the spreading of seafloor anoxia, in order to unravel the interlocking of the different mechanisms and their specific impact on anoxia through space and time.