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Introduction

Cretaceous anoxic events may have been triggered by massive volcanic CO_2 degassing as large igneous provinces (LIPs) were emplaced. Here, we present a comprehensive modeling study to decipher the marine biogeochemical consequences of enhanced volcanic CO_2 emissions. A biogeochemical box model is used for transient model runs with time-dependent volcanic CO_2 forcing. The model considers continental weathering processes, marine export production, degradation processes in the water column, the rain of particles to the seafloor, benthic fluxes of dissolved species across the seabed, and burial of particulates in marine sediments. To estimate horizontal and vertical fluxes between boxes, a coupled ocean-atmosphere general circulation model (AOGCM) is run to derive the circulation patterns of the global ocean under Late Cretaceous boundary conditions.



Biogeochemical modeling withthe BPM (Benthic Pelagic Module)





Conclusions

•With an appropriate choice of parameter values the model produces ocean anoxia at low to mid latitudes and changes in marine $\delta^{13}C$ that are consistent with geological data. • An additional mechanism might contribute to anoxia, an increase in the C:P ratio of marine plankton is induced by high pCO₂ • The AOGCM model results imply an intensively ventilated Cretaceous ocean that turns anoxic only if the C:P ratio of organic particles exported into the deep ocean is allowed to increase under high pCO_2 . •Being aware of the uncertainties such as diagenesis, this modeling study implies that potential changes in Redfield ratios might be a strong feedback mechanism to attain ocean anoxia. • Formation of C-enriched marine organic matter may also explain the frequent occurrence of global anoxia during other geological periods characterized by high pCO_2 .

Flögel, S., Wallmann, K., Poulsen, C. J., Zhou, J., Oschlies, A., Voigt, S., and Kuhnt, W. (2011): Simulating the biogeochemical effects of volcanic CO₂ degassing on the oxygen-state of the deep ocean during the Cenomanian/Turonian Anoxic Event (OAE2). Earth and Planetary Science Letters 305, 371-384, doi:10.1016/j.epsl.2011.03.018.

Provides vertical and horizontal fluxes for BPM circulation