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Biogeochemical modeling of phosphorus cycling in the ocean: response to long-term perturbations

Virginia Palastanga (1), Caroline Slomp (1), Christoph Heinze (2), and Arne Winguth (3)

(1) Utrecht University, Faculty of Geosciences, Utrecht, Netherlands (v.palastanga@geo.uu.nl), (2) Geophysical Institute, University of Bergen, Bergen, Norway, (3) Department of Earth and Environmental Sciences, University of Texas Arlington, Arlington, Texas

Phosphorus (P) is likely the limiting nutrient for marine primary productivity on geological time scales. Therefore, insight into the mechanisms that control P cycling and burial in marine sediments is of importance for our understanding of global biogeochemical cycling and climate. Here, we use a version of the Hamburg Oceanic Carbon Cycle biogeochemical ocean model (HAMOCC2) expanded with the sedimentary P cycle, i.e. burial of organic P and formation and burial of Fe-oxide bound P and authigenic Ca-P minerals. We also include anaerobic degradation of organic matter in the sediment and a description of the oceanic Fe cycle which takes into account aeolian input and scavenging of iron onto sinking particles. For present-day climate forcing, the model predictions for the solid forms of sediment P and benthic P fluxes are compared to observations from global surface sediments. In a sensitivity study, the relationships between primary productivity, nutrient cycling, and organic C and P burial are analyzed for scenarios of increased input of P from rivers as well as for changes in aeolian deposition and circulation forcing that represent Last Glacial Maximum conditions.