Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.19528

Carbon cycle implications of a dynamic, climate-sensitive biological pump

MARKUS ADLOFF[1], ASHLEY DINAUER[2], CHARLOTTE LAUFKÖTTER[1], FRERK PÖPPELMEIER[1], AURICH JELTSCH-THÖMMES[1] AND FORTUNAT JOOS[1]

[1]University of Bern

[2]Woods Hole Oceanographic Institute

Presenting Author: markus.adloff@unibe.ch

Feed backs between the marine biological cycle, atmospheric CO_2, and climate are important for past and future climate evolution. We present a new mechanistic representation of organic and inorganic marine particles in the intermediate complexity Earth system model Bern3D based on the columnar particle flux model MSPACMAM. Instead of assuming globally and temporally invariant sinking profiles, the new scheme calculates sinking speeds and remineralisation/dissolution rates based on ambient conditions. Combined with an improved representation of dynamic iron release and scavenging, this scheme introduces new complexities and feedbacks in the response of the biological pump to climate and circulation changes in the Bern3D model. Particle decay rates are now functions of temperature, oxygenation, saturation states with respect to aragonite and calcite and sinking speed, which in turn is affected by changes in export production (amount and composition) as well as the viscosity and density of seawater. Export production is affected by iron availability, which depends on the balance of scavenged and released iron, two processes which depend on particle densities and local oxygen concentrations. We showcase the non-linear implications of these new dependencies in transient and steady-state simulations of different climatic conditions, e.g. temperature and density-sensitive particle concentrations result in shallower carbonate dissolution and altered organic particle remineralisation in the Southern Ocean at the Last Glacial Maximum, and a smaller decline of export production but faster oxygen depletion than with fixed profiles in scenarios of anthropogenic climate change.