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Temperature-dependent remineralization in a warming ocean increases surface pCO_2 through changes in marine ecosystem composition

Joachim Segschneider (1) and Jørgen Bendtsen (2)

(1) Max-Planck-Institute for Meteorology, Hamburg, Germany (joachim.segschneider@mpimet.mpg.de), (2) ClimateLab, Copenhagen, Denmark (jb@climatelab.dk)

Temperature-dependent remineralization of organic matter is, in general, not included in marine biogeochemistry models currently used for Coupled Model Intercomparison Project Phase 5 (CMIP5) climate projections. Associated feedbacks with climate and the carbon cycle have therefore not been quantified. In this study we aim at investigating how temperature-dependent remineralization rates (Q_{10} = 2) in a warming ocean impact on the marine carbon cycle, and if this may weaken the oceanic sink for anthropogenic CO_2. We perturb an Earth system model used for CMIP5 with temperature-dependent remineralization rates of organic matter using representative concentration pathway (RCP)8.5-derived oceanic temperature anomalies for 2100. The result is a modest change of organic carbon export but more important derived effects associated with feedback processes between changed nutrient concentrations and ecosystem structure. As more nutrients are recycled in the euphotic layer, increased primary production causes a depletion of silicate in the surface layer because opal is exported to depth more efficiently than particulate organic carbon. Shifts in the ecosystem occur as diatoms find less favorable conditions. Export production of calcite shells increases causing a decrease in alkalinity and higher surface pCO_2. With regard to future climate projections, the results indicate a reduction of oceanic uptake of anthropogenic CO_2 of about 0.2 PgC yr^{-1} towards the end of the 21st century. This is in addition to reductions caused by already identified climate-carbon cycle feedbacks. Similar shifts in the ecosystem as identified here, but driven by external forcing, have been proposed to drive glacial/interglacial changes in atmospheric pCO_2. We propose a similar positive feedback between climate perturbations and the global carbon cycle but driven solely by internal marine biogeochemical processes.