

Marine carbon and ecosystem feedbacks in the Earth System

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Earth System Models are routinely used for future projections of the carbon cycle and are by definition simplifications of the real world. The ocean uptake of anthropogenic carbon is to first order a physical-chemical process related to CO₂ solubility and ocean circulation. However, changes in biological productivity and ecosystem dynamics may affect the ocean carbon cycle in the future under on-going climate change. To simulate such marine carbon and ecosystem feedbacks, relevant biological processes, so far mostly neglected for the sake of simplicity or due to missing process understanding, need to be considered in the models.

Here, we present recent developments of the ocean biogeochemistry model REcoM specifically on the extended representation of phytoplankton, zooplankton and detritus sinking speed. We further present research using FESOM-REcoM and the emission-driven AWI-ESM for CMIP6-type simulations that identify a weakening of the biological carbon pump in the Arctic Ocean and of the physical carbon pump in the Southern Ocean in future high-emission scenarios. We address interactions between ocean alkalinity enhancement and phytoplankton productivity and we finally revisit the question of how big the effect of the biological carbon pump on atmospheric CO₂ is.