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Tuning ocean biogeochemistry in the Earth system — insights from the HAMburg Ocean Carbon Cycle model

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Ocean biogeochemistry as part of the Earth system impacts the uptake of atmospheric CO_2 and storage of carbon in the ocean. In the ICON-O (Icosahedral non-hydrostatic general circulation model) ocean model, ocean biogeochemistry is represented by the HAMburg Ocean Carbon Cycle model (HAMOCC; Ilyina et al. 2013, Mauritsen et al. 2019, Maerz et al. 2020). Here, we present the results of an ongoing effort to tune HAMOCC (i.e. adapt parameters within the uncertainty range) to accommodate the ocean circulation simulated by ICON-O.

The tuning of biogeochemical models, including HAMOCC, has previously been an iterative, and a rather random process combining expert knowledge and a suite of parameter testings. A documented, systematic procedure, describing how to tune these models is lacking. Therefore, while tuning HAMOCC in ICON-O, we aim at filling this gap by structuring the process and documenting the steps taken to tune a biogeochemistry model in a global general ocean circulation model.

The ocean circulation has a large impact on the distribution of biogeochemical tracers, as biases in the circulation will, for example, impact the upwelling of nutrients or the CO_2 exchange with the atmosphere. We investigate the impact of physical parameterization such as the Gent-McWilliam eddy parameterization and the vertical mixing scheme on the choice of HAMOCC tuning parameters. We then compare the spatial distribution of major state variables such as nutrients and alkalinity to observational data (WOA; Garcia et al 2013, GLODAP; Key et al 2004) and evaluate the key tendencies such as CO_2 surface fluxes and attenuation of particulate organic matter fluxes. Furthermore, we discuss the tuning steps, choices of the tuning parameters and their impact on the simulated biogeochemistry. The envisioned outcome of this work is a tuned ocean biogeochemistry component for the here used ICON-O model and a more generalized tuning procedure that can be applied to other models or HAMOCC in different model configurations (coupled runs, different resolution).

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