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Impact of resolved scales on global marine biogeochemical models

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The global marine biogeochemical system is an integral part of the Earth system and carbon cycle. Like many other fields, as computer power improves so also has the trend towards using higher resolution in an effort to capture a greater proportion of the real world in the models. In the framework of the EU-FP7 GreenSeas project we examine this approach by performing two simulations of the global marine biogeochemical system, one at 2 degree resolution (LO-res), and the other at 1/4 degree resolution (HI-res) using the PELAGOS model, a coupling between NEMO and the BFM. Both the LO-res and HI-res simulations are set up with the same initial conditions, forcing and biogeochemical parameterizations, allowing us to perform a direct inter-comparison of the two, with a special focus on the Atlantic ocean. We examine how resolving more of the physical features affects the biogeochemical system, in particular how differences in the resolved horizontal, vertical motions and the mixed layer depth are reflected in the plankton biomass, the nutrient availability and community structure. While the global large-scale oceanographic features (fronts, gyres, etc) are captured in both the LO-res and HI-res simulations, differences in the mesoscale flow structures, and in particular the resolved vertical physics in the HI-res simulation, drive very different behaviour in the biogeochemical system. These differences in the physics drive what is a spun-up biogeochemical system in the LO-res simulation into a new regime in the HI-res simulation, where overall there is greater nutrient availability and much higher total primary production. Overall this approach identify the importance of resolving the vertical dynamics in marine biogeochemical models and opens up the question of the sensitivity of the parameterizations to the resolved scales.

Keywords: Atlantic ocean, resolution, biogeochemical, models