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Sensitivity of the emergent behavior of a complex ecosystem model to choice of ocean general circulation model

Bablu Sinha (1), Erik Buitenhuis (2), Corinne Le Quere (2), and Thomas Anderson (1)

(1) National Oceanography Centre, Southampton, Ocean Modelling and Forecasting, Southampton SO14 3ZH, UK (bs@noc.soton.ac.uk), (2) School of Environmental Sciences, University of East Anglia, Norwich, NR4 T7J, UK/British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET, UK (e.buitenhuis@uea.ac.uk)

Numerical simulations were conducted using a state of the art complex marine ecosystem model embedded separately in two medium resolution (order 1º) global ocean general circulation models (OGCMs), NEMO and OCCAM. The ecosystem model, PlankTOM5.2 simulates the distribution of five plankton functional types (PFTs; mixed phytoplankton, diatoms, coccolithophores, micro- and mesozooplankton). In both simulations the ecosystem model had the same equations, parameter values, biogeochemical forcing (photosynthetically active radiation and input of nutrients by atmospheric dust at the ocean surface) and initial conditions. The same surface boundary conditions were imposed on the two physical models, subject to interpolation between the two model grids, The simulations were performed for years 1990-1994.

Sensitivity of the ecosystem model biology and biogeochemistry was assessed with respect to differences in the ocean physical fields in the two simulations. Globally integrated bulk properties such as annual mean primary production were similar in each case and were generally consistent with available observations. In contrast, predicted distributions of individual PFTs varied markedly between the two simulations. The OCCAM simulation predicted that diatoms and microzooplankton dominate in the North Atlantic, North Pacific and Southern Oceans because relatively strong mixing supplies increased nutrients that favour diatom production and increase the mortality of their main predators, the mesozooplankton. In the NEMO simulation, weaker mixing led to a community structure in which mixed phytoplankton and mesozooplankton dominate in the aforementioned areas. Regions of dominance by coccolithophores and mixed phytoplankton were predicted in the tropics, with distributions depending mainly on the different size and extent of up- and downwelling regions predicted by the OGCMs. Results highlight the need for accuracy both when formulating the equations for, and parameterising, PFTs in models, and moreover in the representation of the physico-chemical environment.