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Adaptive meshes in ecosystem modelling: a way forward?

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The need to resolve physical processes occuring on many different length scales has lead to the development of ocean flow models based on unstructured and adaptive meshes. However, thus far models of biological processes have been based on fixed, structured grids which lack the ability to dynamically focus resolution on areas of developing small-scale structure.

Here we will present the initial results of coupling a four component biological model to the 3D non-hydrostatic, finite element, adaptive grid ocean model ICOM (the Imperial College Ocean Model). Mesh adaptivity automatically resolves fine-scale physical or biological features as they develop, optimising computational cost by reducing resolution where it is not required.

Experiments are carried out within the framework of a horizontally uniform water column. The vertical physical processes in top 500m are represented by a two equation turbulence model.

The physical model is coupled to a four component biological model, which includes generic phytoplankton, zooplankton, nitrate and particular organic matter (detritus). The physical and biological model is set up to represent idealised oligotrophic conditions, typical of subtropical gyres. A stable annual cycle is achieved after a number of years of integration.

We compare results obtained on a fully adaptive mesh with ones using a high resolution static mesh. We assess the computational efficiency of the adaptive approach for modelling of ecosystem processes such as the dynamics of the phytoplankton spring bloom, formation of the subsurface chlorophyll maximum and nutrient supply to the photic zone.