

Interactive comment on “Adapting to life: ocean biogeochemical modelling and adaptive remeshing” by J. Hill et al.

Anonymous Referee #2

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Review of “Adapting to life: ocean biogeochemical modelling and adaptive remeshing” by J. Hill, E. E. Popova, D. A. Ham, M. D. Piggott and M. Srokosz

The paper investigates the impact of different vertical resolutions on simulated mixed layer depth as well as on some biogeochemical variables in a 1D setup of a coupled ocean biogeochemical model. In particular, the applicability and benefit of an adaptive mesh is tested with respect to the biogeochemistry. While the major question per se is interesting, the paper could be shortened considerably and some major issues have to be addressed:

GENERAL COMMENTS:

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(1) To rate the study, it would be important to know how large the impact of the resolution is compared to other uncertainties as e.g., the surface forcing, the parametrization of the mixed layer depth, the solar absorption profiles etc.. Also, preceding studies addressing similar issues should be mentioned.

(2) Generally biogeochemical models are tuned based on a certain resolution to fit some observations as good as possible. It can thus not be expected that a higher resolution will generally make the model look more realistic. Also, a good fit to the observations cannot be expected in this study since advective processes are neglected. The argumentation in the paper should be changed sometimes and probably idealized studies, illustrating sensitivities and effects, would give a better picture. Of course the stations could be still mentioned to illustrate that the idealized studies are based on realistic conditions. For which resolution and region was the model originally designed?

(3) Typically, 3D ocean circulation models feature a much higher resolution at the surface than at depth, while the present paper assumes equal spacing at all depth levels. Typical resolutions in 3-D ocean models should at least be mentioned or (better) be added.

(4) The whole section about method explanations is difficult to read/understand. To make it easier, the explanations should stick to the version actually used in the study and not other available options in the applied software package. The explanations are sometimes relatively vague, e.g. it does not get clear how the weights are chosen to optimize the adaptive grid, which initial values were used for the biogeochemical model and if the model shows some initial drift. The criterium how the MLD is defined is apparently missing (is it the same criterium for model and observations?) and also I did not find how “surface values” are defined. When introducing the biogeochemical model briefly in the text all prognostic variables should be mentioned and particular also how chlorophyll is treated (since many models assume a fixed Chlorophyll_a:P ratio). At the same time, some other explanatory parts could be shortened considerably (e.g. not all formula need to be given but citation is sufficient (or if they are given they should be

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explained and the notations should be used consistently throughout the manuscript); the first passage when explaining the biogeochemical model is non-necessary etc.).

(5) The authors state that the use of an adaptive grid could save considerable computing time since the number of necessary vertical levels can be strongly reduced while the results remain basically identical. How difficult is it to implement a varying number of vertical levels in 3D and how much would this again increase the computational cost?

SPECIFIC COMMENTS:

ABSTRACT: In 1D most of the mentioned processes cannot be addressed. The abstract should stick more to what actually was done.

INTRODUCTION Also the introduction could stick a bit more to the investigated issue. 3D ocean models using adaptive grids in the vertical are already used, e.g., at IOW Warnemuende. It would be good to mention and discuss preceding studies. What is new about the present study?

Examples: Burchard, Hans, and Jean-Marie Beckers. "Non-uniform adaptive vertical grids in one-dimensional numerical ocean models." *Ocean Modelling* 6.1 (2004): 51-81.

Hofmeister, Richard, Hans Burchard, and Jean-Marie Beckers. "Non-uniform adaptive vertical grids for 3D numerical ocean models." *Ocean Modelling* 33.1 (2010): 70-86.

HYDRODYNAMICS MODEL I would recommend to change the title of this section (Methods?). Some parts are common knowledge and could be shortened, while sometimes important information is lacking (see major point 4). Particularly, the mesh optimization did in principle but not in detail get clear to me.

MODEL VERIFICATION I would rather call this "model evaluation" – however, as stated above I don't think it makes much sense to measure the model-data misfit in the present setup and the section might be renamed anyway. Also, it is a bit lengthy to go through

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the same results for all three stations. Instead only remarkable situations could be highlighted.

ADAPTIVITY The “Metric formulation” as well as the interpolation methods should be moved to the Method section (which is now called “hydrodynamical model”).

FIGURES: The number of figures is much too high while many figures show basically the same thing. Also, it would generally help a lot if the name of the respective variable would be written into the sub-panels (Fig. 2, 3, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15). The symbols representing the observations are sometimes very small.

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