

Dear Reviewers,

You will find here below our replies point by point to each of your comments.

We have prepared a revised version of the manuscript that incorporate all the changes mentioned in our replies. In particular, we have:

- 1) clarified and reformulated in the text some model formulations (benthic, optical, phytoplankton groups composition).
- 2) added additional model-data comparison (adding additional validation) Yet this paper is not a validation paper and a companion paper will describe in details the validation of the model over 1950-2025.
- 3) moved to the appendix some materials to lighten the main text.
- 4) made the minor corrections suggested.

We thank both reviewers for the time they spend reviewing our work.

Kind regards,

Marilaure Grégoire on behalf of the coauthors.

Comments of the reviewer in normal, our answer in italics.

Answer to reviewer #2

This study describes a biogeochemical model for simulating dissolved oxygen and benthos including detailed formulations and parameters. This model is especially well presented including sufficient details. I appreciate the author's efforts making the model clear, well explained, and open-source for the readers. I have a few comments and suggestions before the manuscript is ready for publication

- 1) Section 2.1, please indicate the reason of having three phytoplankton groups. What is the biomass/proportion of these three groups? What are the different roles of these three groups in oxygen cycling and benthic activities? In Figure 1, please change nanophy and microphy to nanoflagellates and microflagellates. Otherwise it is confusing because also diatoms have both size categories, nano and micro.

BAHMBI involves three plankton functional groups differentiated based on their size (micro-, nano) and for micro differentiating silicifiers (flagellates) versus non-silicifiers (dinoflagellates). The relative composition of each group is explicitly simulated. In the case of the Black Sea it varies in time, with first the diatoms at the surface then the two flagellates at depth in summer.

These three groups play the same role as concerns the oxygen budget: they produce oxygen via photosynthesis and nitrate reduction, consumes oxygen via respiration. As concerns the connection with the benthos, diatoms sink to the bottom and when the three groups die, they become detritus that sink and are degraded in the water column or in the benthos.

We have corrected all the figures.

- 2) Why do the shelf data in 5.1 last only till 2002? Any recent bottom DO observations in WOD?

Indeed the number of data drastically drops after 2001 because the maintenance of a Black sea data base was not continued. Then dataset are fragmented and not always openly available. We use Argo for the last 15 years.

3) Section 5.2, can you show how much the halocline is overestimated? Any suggestions on how to improve the overestimation of the halocline?

We have added a justification of the reasons of weakening of the halocline. Yet, this paper focuses on the presentation of the biogeochemical model. We are not presenting results from the physical model but will have a specific paper dedicated to that.

4) Please add some discussion on how well the presented DO and benthic model is compared to other models with similar functions, e.g., in complexity and model performance.

This comparison would be indeed very interesting but much beyond the scope of this paper.

5) L 737, any likely explanation why the model overestimates DO in most years?

The median of the model bias is very small with usually a positive bias lower than 10 $\mu\text{mol L}^{-1}$ (except in 1998) though in 1991 and 1997 the model underestimates the oxygen concentrations with a bias lower than 25 $\mu\text{mol L}^{-1}$. So sometimes the model underestimates, sometimes it overestimates but the bias low. Since, the bottom oxygen values are really dependent on the bottom oxygen consumption and temperature, it is possible that this bias is due to an error in the temperature field or in the sedimentary organic content. This has been added in the revised version.

6) Would be great to include validation of bottom temperature and surface DO to help interpret the model performance presented in Fig. 6-10.

We have added a plot of surface DO . Thank you for the suggestion.