

Reviewer 1 response to author's comments

GENERAL

I am a little bit confused in general by the authors response, which seems directed purely at me and which includes references to changes in the future tense (“we will”). My confusion on certain descriptions can be shared by others, and therefore the authors should not explain things directly to me but in the manuscript text. And they should state clearly where they have included new or altered text, for instance “in line xxx we have now included the following text: ...” so that reviewers like me can see what alteration have been included. Statements like “we will extend the model description section to clarify the model structure” without stating the actual changes made do not allow me to judge the changes made to the manuscript to assess improved readability. Now I had to search for changes in the resubmitted text, which did not include track changes of any form, in order to locate any alterations. These seemed to be semantical throughout, with the only real addition in the new section *4.3 Model limitations and perspectives*, where the authors have included some discussion on some of the reservations I had towards the applied model.

Model limitations are better included now, in said section, including the lack of bacterial dynamics and sediment nutrient budgets. Figures have been enlarged and are much more readable, and there is a better model description in the manuscript, outlining differences with existing models. However, the impact of benthos is still not discussed and the authors remain, in my view, rather optimistic about the performance of the biological part of their model. They did downscale their conclusions on the biological impact somewhat by stressing that the results are indicative of a system response, rather than a predicted ecosystem state.

Some detailed responses are given below.

1. “It is not entirely clear to us, what is meant by ‘why not use ECOHAM for that’. If it means directly applying a readily available ECOHAM setup, this was not an option: to the best of our knowledge, the only available HAMSOM-ECOHAM setup, performance of which have been sufficiently documented (e.g., Große, 2017), is simply too coarse (20 km horizontal resolution, and 7 z-levels within the deepest part of the study area) for being able to capture the meso-scale features of the system, in particular, the haline stratification caused by the Elbe river (Pätsch et al., 2017).”

I was not referring to an existing setup (an application of a model to a certain area), but to a model itself (ECOHAM), therefore I do not understand the given response: horizontal and vertical resolutions can be adapted to create a more suitable setup. It may not have been practical (is there a FABM version of ECOHAM?), but that is another reason. It seems to me the choice of model was based on availability and previous experience, rather than a careful process of selecting the best suitable model for the desired application. This is fine, and common practice in a world limited by project deadlines and budgets, but it should be stated as such. Including the limitations of this model compared to others. Within the new manuscript the model is now compared to others applied in the same area, which is somewhat limited.

5. "It was again not entirely clear to us what is exactly meant by 'a model with benthos' by the referee."

I am a bit mystified by the authors answer. They state that they do not understand the line "a model with benthos", and then proceed to detail some of the abiotic benthic processes included in the model. Even if by rare chance they really do not know the meaning of the word "benthos" (organisms living in, on or near the seabed) it is easy to look it up. And they should explain in the manuscript the importance of benthic organisms in sediment dynamics and seabed nutrient budgets, and the possible impact of not including these dynamics on their results. In shallow coastal areas the benthic compartment forms an integral part of the local ecosystem, including its carbon and nutrient pathways. At the moment this is not included in the added section 4.3. The impact of burrowing or filter feeding animals on water quality is not negligible. Neither are algal mats preventing resuspension.

Response: There are certainly more complex models, but considering the purposes of our study, it is not clear in which specific sense would such a model be better suited. It should be noted that, with regard to benthic/pelagic coupling, models of similar complexity have been used until recently, for studying the nutrient concentrations and bottom oxygen conditions in the North Sea (e.g., Große et al., 2017, using ECOHAM), as well as other similarly dynamic coastal shelf systems such as the Louisiana Shelf (e.g., Fennel and Laurent, 2018) or even shallower systems such as the Chesapeake Bay (Irby et al. 2018).

Response: necessity for the presentation of a validation of benthic nutrient concentrations of fluxes (which is very rarely done in studies similar to ours) is not clear.

There are, as said, more complex models out there. The question is whether they do a better job of describing the pelagic-benthic coupling and resulting pelagic nutrient concentrations in shallow areas, by allowing for bio-turbidity, bio-irrigation, filter feeding and long-term storage of nutrients and as such creating more dynamic sediment nutrient profiles and benthic-pelagic nutrient fluxes. Validation is indeed seldom done, and it is hard to get "right" compared to in-situ measurements (which are mere snapshots), but that doesn't mean it shouldn't be done. It would be good to know if the fluxes as produced by the model are comparable to observations, to get an idea of 1. The importance of benthic-pelagic fluxes in the area for pelagic nutrient concentrations (particularly in stratified conditions) and 2. The (possible) limitations of the simple benthic module.

L201 "A consistent source of error seems to be the failure of the model to estimate the timing of the spring bloom"

This is a serious issue and I appreciate the authors frankness regarding it. It is difficult to get the timing correct, but in essence the main aim of a coastal biogeochemical model is just that: to assess/predict/be able to analyse coastal productivity. To have this as a consistent error is worrying and suggests the biogeochemical model is missing some key drivers / processes, as indicated by the lack of good Chl validation results. Which is why I do not share the confidence of the authors in the presented biogeochemical model.

L417 *“oxygen consumption and denitrification (Fig. 2) were largely based on ECOHAM (see Section 2.1 Appendix B), which was earlier derived from ERSEM.”*

The ERSEM model is mentioned a few times in the text, but only with the references of Ford et al (2017) and Blackford and Radford (1995). In line 417 it is mentioned for the first time without any references at all. I strongly suggest including the original ERSEM publications by Baretta and Baretta-Bekker, in order to give credit where credit is due:

Baretta JW, Ebenhöh W, Ruurdij P (1995) The European Regional Seas Ecosystem Model, a complex marine ecosystem model. *Neth J Sea Res* 33(3/4):233–246

Baretta-Bekker JG (ed) (1995) European Regional Seas Ecosystem Model I (1990–1993). *Neth J Sea Res* 33(3/4):229–483

Baretta-Bekker JG, Baretta JW (eds) (1997) European Regional Seas Ecosystem Model II (1993–1996). *J Sea Res* 38(3/4):169–436

L445 *“which is out of the scope of this study.”*

I have never heard the combination *“out of the scope of”* before, *“outside of the scope of”* is more common.

L457 *“However, the model structure and formulations represent the state of the art”*

I find this very bold, given the fact that the benthic compartment is mainly parameterized, mixotrophs are not included, bacterial dynamics are not directly included and different algal groups are not represented (e.g. the mentioned *Phaeocystis*). The model is not bad, and will be near state of the art with the additions and developments mentioned in the text. But this is not the model applied here.