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Ocean Science Discussions

Interactive comment on "Numerical modelling of POC yearly dynamics in the southern Baltic under variable scenarios of nutrients, light and temperature" *by* L. Dzierzbicka-Glowacka et al.

Anonymous Referee #2

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The objective of this study was to simulate the contemporary seasonal dynamics of particulate organic carbon (POC) in the southern Baltic as well as its possible changes in the future. Unfortunately, the implemented means do not match this important goal: the chosen approach neglects important Baltic Sea features and validity of the model was not demonstrated. Consequently, presented numerical experiments could only be considered as a mere learning exercise, which publication would, perhaps, be appropriate two-three decades ago but not nowadays. Therefore, I cannot recommend this manuscript for publication, especially in the Special Issue of OS presenting results of "...Operational... forecasting systems"

General comments

1. Both model formulation and its setup totally disregard a well-described "vicious circle" determined by feedbacks in a coupled nitrogen and phosphorus cycles: primary production of sinking POC = > expanding hypoxia = > simultaneous decrease of DIN and increase of DIP = > increased cyanobacterial nitrogen fixation re-introducing nitrogen into biotic cycling. (In fact, neither cyanobacterial blooms nor nitrogen fixation were mentioned in this MS even once.) Consequently, future PP would be determined not just by future nutrient pools but also by their DIN:DIP ratio that cannot be predicted from linear interpolations of trends estimated at 1965-1998 time interval. In result, the quantitative reliability of obtained increases of PP and POC, which were predictably generated by some prescribed increases of temperature, light, and nutrients, cannot be evaluated.

2. Another important feature of the Baltic Sea eutrophication is long nutrient residence times ("system memory"), which requires long continuous (transient) computations, accounting for bottom-water interactions and advective transports, instead of annual slices, presented in MS.

3. MS contains neither model validation nor any justification of its applicability for chosen locations. Meanwhile, as could be deduced both from the manuscript and from Dzierzbicka-Glowacka et al. (2010) for the Gdansk Deep: a) deep-water nutrient pools are greatly overestimated, most likely because of ignoring oxygen dynamics and its effects on the nitrogen and phosphorus fluxes; b) annual nutrient cycles are not closed, which means misbalanced dynamics and would result in artificial long-term trends; c) maximum development of zooplankton in the reference conditions 1965-1998 occurs in June-July, i.e. one-two months earlier than in reality, which implausibly affects summer nutrient regeneration. Note also, that simulated nutrient dynamics were neither demonstrated, nor even mentioned in the manuscript. Were these simulated at all?

4. The entire MS is loosely composed and poorly written, omitting many important

details in presentation of the model formulations and set-up of numerical experiments, while excessively lengthy in a mere description of pictures.

5. Finally, I share all the doubts expressed by another reviewer but I'm not satisfied by most of the answers presented in Interactive Discussion by authors.

Specific comments

1. "The flow field" and "the velocity components xi" are mentioned both in this manuscript and in Dzierzbicka-Glowacka et al. (2010, Eq. 2) without any explanations how they were implemented in 1D case without violation of the conservation.

2. How deep is modelled domain and what is a vertical resolution (depth step)? What is a specific reason in a consideration of both surface and upper layers in the Gdansk Deep but only upper layer in the Bornholm and Gotland deeps.

2. Formulation of the ecosystem model is also rather unclear. For instance, what are the units (currency) of state variables? In the Gdansk Deep a seasonally variable C:Chl ratio was used for calculation of light extinction (Dzierzbicka-Glowacka et al. 2010). What was used in the Bornholm and Gotland deeps?

3. At p. 680: "The average chlorophyll-a concentrations in the southern Baltic Sea (average values for 1965–1998 period) were used in this model for the calculation of primary production (Table 1)" How?

4. "nutrients increase 1% of an average annual value per year." What is an average annual value for a variable with a pronounced seasonal change, from winter nutrient maximum to (almost) zero in summer?

5. At p. 679: "In this model nutrients are represented by two components: total inorganic nitrogen ($NO-3$ + $NO-2$ + NH+4) and phosphate ($PO3-4$ 15)." At p. 681: "Based on the trend indicated above, daily...variabilities of primary production, phytoplankton, zooplankton, pelagic detritus and particulate organic carbon (POC) in different areas... were calculated for the different nutrients concentrations... and wind

speed scenarios." What does "nutrient scenario mean", what was estimated with linear trends – initial conditions for annual slices or the entire seasonal curves? In other words, were nutrients seasonal dynamics simulated or just prescribed? If the later, then the entire exercise in calculation of phytoplankton, detritus and zooplankton from prescribed nutrient variations could hardly be considered as an ecosystem modelling. Ignoring mechanisms of the summer nitrogen fixation and regeneration would also make the simulated summer dynamics of POC unrealistic and conclusions based on it unreliable.

6. "Primary productivity and POC concentrations calculated for the period 1965–1998 and 2010 agree well with experimental data." Such statements must be justified.

7. Just an example of unclear writing: "Contemporary POC concentrations are modelled under a variety of increased temperature and nutrients scenarios" How can contemporary concentrations be simulated under increased scenario forcing?

8. Nowadays, there are several Baltic ecosystem models much better suited for scenario simulations and actually performing them, that authors largely failed to mention, unfortunately.

Interactive comment on Ocean Sci. Discuss., 8, 675, 2011.