

## ***Interactive comment on “Evaluation of atmospheric nitrogen inputs into marine ecosystems of the North Sea and Baltic Sea – part A: validation and time scales of nutrient accumulation” by Daniel Neumann et al.***

**Anonymous Referee #3**

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This manuscript presents and evaluates a coupled physical biogeochemical model HBM-ERGOM forced by modelled atmospheric deposition of nitrogen for its ability to simulate dissolved inorganic nitrogen (DIN), dissolved inorganic phosphorus, silicate, oxygen, and chlorophyll-a in the seawater of the North and the Baltic Seas. With the aim to be used (in a companion paper) to evaluate the impact of the deposition flux from shipping and agricultural emissions of N to the marine ecosystems, the model is tagging the nutrients in the seawater and their penetration into the ecosystem components, i.e. uses source specific nutrients to evaluate their propagation in the marine

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environment and their impact. This approach is very interesting and the information that could be derived from its proper implementation is expected to increase our understanding of the environmental impacts of anthropogenic N inputs to the ocean.

The main result presented in this manuscript is the residence time of N and P in the studied region, which agrees with the existing literature. This somehow provides some indications that the model is not totally unrealistic.

However, the model as presented has a number of important shortcomings also mentioned by reviewer #2, which show significant deficiencies in the model's ability to simulate the marine N cycle. Lacking DIN depletion in summer (p. 20, line 3), a period over which it is expected that the atmospheric deposition will maximize because of the stratification of the seawater, will definitely introduce large inaccuracies in the calculated impact on the marine ecosystem. Therefore, as presented the quality of the modeling is questionable.

However, the authors use the first year of their simulation to validate their model, while they clearly say in the manuscript that their model did not reach a steady-state and they finally use the 2nd or 5th year to further investigate the impacts of atmospheric deposition. I would expect to see a model validation for the iteration that is used for the impact study, since the others appear as spin-up time for their model system. This might provide totally different results for the model evaluation.

In case that the last iteration is better representing the N marine cycle than what is actually shown in the manuscript and discussed, then it might be worth considering publishing this work to BG if it fulfills my comments below or to another journal, more appropriate for model description.

The manuscript has to be significantly shortened, focused and needs clarification in several parts. The key message of the manuscript has to be the evaluation and quantification of the uncertainty in the calculations and has to be reorganized in this direction. Several parts of the present manuscript can move to the supplement. To be suitable

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for BG the manuscript needs also to further elaborate the science question, i.e. the contribution of atmospheric deposition to the DIN in the seawater (based on figure 11 and Figures 6&9). The authors might consider merging it with the companion paper.

Further comments for potential improvements: From all the figures here presented, figures 5, 6, 9 and 11 are the most informative for the purpose of the surface validation discussed here. In figure 6 and 9, I think the simulation that will be used for the impact study has to be evaluated and not the first one. Fig 11 shows the tagged DIN but then it is not a contribution, for contribution one is expecting to see a ratio or a % value to the total DIN in the seawater. Also consider merging parts of Fig 6/9 and 11? Table 2 and 3 could be merged and additional literature data could be added for comparison. Finally, It is often confusing whether DIN concentrations in the atmospheric deposition or in the seawater are discussed/ shown in the figures. Also figures caption have to be more informative, e.g. is surface seawater composition shown or something else?

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