

# ***Interactive comment on “Evaluation of atmospheric nitrogen inputs into marine ecosystems of the North Sea and Baltic Sea – part B: contribution by shipping and agricultural emissions” by Daniel Neumann et al.***

**Savchuk (Referee)**

oleg.savchuk@su.se

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Reviewer’s comments to manuscripts by Neumann, D., Karl, M., Radtke, H., and Neumann, T. “Evaluation of atmospheric nitrogen inputs into marine ecosystems of the North Sea and Baltic Sea – part A: validation and time scales of nutrient accumulation; part B: contribution by shipping and agricultural emissions” submitted to “Biogeosciences”

The study aims at a detailed quantitative description of the pathways and effects of

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atmospheric nitrogen inputs in the marine ecosystems of the North and Baltic seas as simulated with the coupled physical-biogeochemical model HBM-ERGOM. The sine qua non precondition for achieving such ambitious, if somewhat artificial, goal is the realistic simulation of biogeochemical nitrogen cycling in both marine systems. That's why both manuscripts must be considered together, starting from the model itself. Unfortunately, the implemented model version is not suitable for such studies in many aspects: A) by deficient formulations; B) by failing in reproducing some phenomena crucially important in nitrogen cycling; C) by flawed set-up of numerical experiments and validation; and, finally, D) by poor model-data comparability. All these, taken together convert presented results in merely casual exercises that have little to do with the realistic cycling of atmospheric nitrogen in marine ecosystems. That's why I would not even go further into detailed reviewing of "tagged" results. Instead, I recommend to reject both manuscripts and advice against using this version of HBM-ERGOM model, made for operational purposes (perhaps, with the data assimilation), for the long-term studies.

A few examples of crucial flaws and drawbacks are given below.

A) "Iron reduction and release of phosphate under anoxic conditions in the sediment are not represented in this ERGOM version" (Part A, L 15/8). Fixing sediment N:P ratio and ignoring redox alterations of the P cycle implausibly affects phosphate dynamics, hence, distorts such important flux as nitrogen fixation and the following cycling of fixed nitrogen. The necessity of Si restarting for every year indicates that its dynamics even during the first iteration is erroneous with corresponding consequences for phytoplankton seasonal succession and nutrient uptake. Finally, many important features and phenomena, for instance, nutrient limitation, nutrient residence times, species composition, tides and oceanic impacts, etc., are rather different between the North and Baltic seas. That makes combining them into a single domain questionable, if not harmful for the objectives of this study.

B) Overestimated deep layers oxygen concentration and underestimated denitrification

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distort DIN distribution and dynamics (see comparisons in Figs. 7-10). Together with questionably reproduced nitrogen fixation, such underestimation indicates a wrong balance between nitrogen sources and sinks, hence, biases evaluation of atmospheric N contribution to unknown degree.

C) “Therefore, a detailed validation of the nitrogen deposition data sets is not possible and it is not clear whether the CMAQ nitrogen deposition is actually too low over sea.” (Part A, L16-18/13). Already this statement makes studies of the RELATIVE contributions rather uncertain. Further uncertainty (due to possible non-linear effects in the biogeochemical cycling) is introduced by the repetitive implementation of deposition computed only for one year (i.e. 2012) over all five years, forcing a possible deficit accumulation.

D) The model set-up and simulated dynamics contain many features that are “typical within order of magnitude” rather than year-specific. Therefore a comparison of the “first” iteration with observations during concrete 2012 year looks very optimistic, even naïve. Perhaps, such choice partly explains why most patterns of seasonal dynamics are very poorly reproduced either in timing or by the levels, or both (Figs. 7-10). Never mind the plausible oxygen dynamics in the surface layer, where it is mainly driven by air-sea gas exchange. Moreover, the focusing of analysis at the surface layer is unwarranted because the nitrogen biogeochemical cycle must be evaluated for the entire ecosystem, including sediments.

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