

Earth Syst. Dynam. Discuss., referee comment RC2
<https://doi.org/10.5194/esd-2021-33-RC2>, 2021
© Author(s) 2021. This work is distributed under
the Creative Commons Attribution 4.0 License.



Comment on esd-2021-33

Anonymous Referee #2

Referee comment on "Baltic Earth Assessment Report on the biogeochemistry of the Baltic Sea" by Karol Kuliński et al., Earth Syst. Dynam. Discuss.,
<https://doi.org/10.5194/esd-2021-33-RC2>, 2021

Review of Baltic Earth Assessment Report on the biogeochemistry of the Baltic Sea

by K. Kulinsky et al.

The authors wrote a long report on the functioning and evolution of several major Baltic Sea biogeochemical cycles, in particular of water, nutrients (including primary production/eutrophication and oxygen), carbon (mainly focusing on inorganic carbon), and some pollutants. Also included is an overview of advances in research on microorganisms that are involved in and mediate some of the cycles. The author team aims to synthesise published knowledge in analogy to the IPCC reporting process, in line with past publications (BACC Reports 2008 and 2015) mandated by BALTEX and its successor, Baltic Earth, on climate and environmental change in this unusual and interesting shelf sea. The stated aim is to represent new knowledge that emerged since the last reports.

This iteration of the manuscript review process for a dedicated Special Issue of the journal Earth System Dynamics apparently follows a first review that asked for minor revisions. On that background, the manuscript is in a state that can be published. The effort is ambitious and most of the contents indeed provide some novel insights from observations and numerical modeling. The paper is well written, and although there are inconsistencies in structure and imbalances in thematic lines, there are no real corrections that need to be made.

The manuscript being new to me, on the other hand, some general and specific statements may be in order – perhaps as challenges for a future status report.

This is a consensus report and it is difficult to argue when many eminent researchers and co-authors agree on issues. What I missed is a representation of diverging opinions – what is the point of citing the IPCC process when their method of expressing consensus is not adopted? How certain are authors that changes can be attributed to specific drivers? This in particular is the case in the long sections on nutrients, eutrophication and oxygen deficiency, where according to my knowledge there are diverging opinions that in part may be caused by authors' different working areas and processes pertinent there. Have rigorous attribution exercises been performed?

In many instances the Baltic Sea biogeochemical cycles are described in their basic

functioning (which often are not different from other marine and coastal areas). The claim is to update information provided by previous BACC reports and syntheses, but that intended novelty is often swamped by general statements and descriptions in several of the chapters. For example, there is a substantial amount of text dedicated to nutrients and eutrophication effects, including oxygen deficiency – this offers little in terms of new data/ideas. In line with this impression is the enormous list of references, which for the most part have been published before the reporting period. The authors should have been more rigorous in presenting advances that emerged over the last years!

Although the structure of individual chapters (basic principles, past, present, what do models say about the future) makes sense, the outlook to future changes often is speculative (signaled by choice of words such as “would be, may be, possibly etc.”). How certain are you (see above)? Furthermore, the structure is not rigorously maintained throughout the paper. Some of these projections are based on models of varying complexity, but they apparently have not been rigorously evaluated against each other, although it appears that results of different models differ. Many of the outlooks thus are conjecture or reflect opinions.

The microbiology part is essentially a status report on the state of research on “omics”, which may be timely. The chapter on pollutants on the other hand does not offer any new information and treats “traditional” pollutants only, although there have been reports on some of the large spread of novel pollutants in the Baltic Sea.

The following are some further comments and suggestions keyed to line numbers:

64: Marine biogeochemistry ... deals with the transport. It is not really a new discipline.

65: ..particular C, N, P, Si....

68: delete On top of that,

69: with its periodicity?

79: wording and comparative: drained by many smaller rivers, is not that densely populated

103: comment: There appears to be controversy on the role of reactive nitrogen, which is not really addressed in the manuscript

111 ff: Further down you state that the present extent of anoxia is the maximum possible extent.

118 ff: comment: Here you state the objective of reporting progress since the last assessment. The following text is a general description of biogeochemical processes in the Baltic, which makes for a very long text.

137: This either is the case for any marine ecosystem, or needs to be extended to include pronounced internal cycling.

155 ff. This is a background on RCPs and some (regionalised) application (in terms of nutrient inputs) for the Baltic Sea and the likelihood that targets of the Baltic Sea Action Plan will be attained under the assumptions made (from line 170). This should be put into the chapter dealing with probable and plausible nutrient inputs. The RCP’s are a way to prescribe model boundary conditions – I would have expected that the results of model projections thus forced would be treated in all subchapters on future developments.

185: playing - river flow or matter? This refers only to model projections – are there any observations?

194: How certain is this? Anything can potentially happen.

201: Is this observation-based? The preceding text is on models only, isn't it?

210: What does however mean here?

213: This phrase is difficult to understand

222: Further down you say that 30% of sedimentary TOC is land-derived - does that match this statement? What is the nature of the positive feedback? Higher CO₂ = more terrestrial TOC = more respiration in the Baltic?

231: What is the role of increasing pH here? pH of river water or of rain?

232: What does however mean here?

239: As stated before, the manuscript would benefit from a more stringent structure of a) observations and b) modeling scenarios

249: What does even mean here?

257: What I get from the entire paragraph is that climate and human effects are important, but that regional differences exist. Is this surprising or new?

283: lowering pace?

Paragraphs 2.1.5 and 2.1.7 both deal with inputs from the catchment – shouldn't they be treated together (observations, past, likely future? And include atmospheric inputs as well?

345 ff: The entire chapter (2.2) on the coastal filter is very long and repetitive/redundant with other parts. It does not really serve the purpose of updating information published since the last assessment.

It would be helpful to define the extent and properties of the coastal filter, because in a sense the entire Baltic Sea is an estuary. Much of the data here relate to the northern Baltic Sea, whereas data for the southern coastal areas is not even mentioned (e.g., those raised in national and European projects).

356: This is doubtful: much more <N> is removed in southern coastal areas based on delta¹⁵N data! Phosphorus is effectively shuttled to depositional basins from these areas. See, for example, papers by Radtke et al. (modeling) and Voss et al. (N-isotopes).

377: This may be the case in northern sub-systems with high humic matter input - it is not the case in southern river discharge areas.

386: This view appears to be very much skewed to northern Baltic.

436: The river plumes and open coasts in the southern Baltic experience significant changes in nutrient ratios from a significant N-surplus to N-deficit.

451: This entire paragraph is very speculative (may happen, can happen etc) - are there any constraints on coastal functioning in the warmer/more humid future from coupled models?

489: This paragraph draws on older data - are there no new data that are relevant for the reporting period since BACC II? As it is, this recaps already published information with limited novelty.

529: What causes the different transport patterns of N and P? Sounds like diffusion, which is unlikely?

545 ff: These are general statements/observations - what is their purpose here?

The data in Table 2 are really old - how can they be relevant to an assessment paper for the present situation?

591: One might mention somewhere that N₂-fixation has been a consistent feature in the Baltic over the last 8000 years or so (papers by Bianchi, Struck) and that the so-called vicious cycle has been a natural phenomenon since the Baltic Sea developed into a brackish system.

612: What can possibly cause that lag of 20 years?

624: Decline in benthic production due to an increasingly anoxic Baltic Proper?

626: might decrease - anything might happen.....

638: How is that if P surplus is a main driver?

655: Lefébure (?) et al., 2013

658 ff: There is no mention of change - only general principles are described

676: deeper....weaker than what?

701: old reference, what is new?

705-712: These are contradictory statements?

710: How is that possible, when increased nutrient loads are responsible (2 paragraphs up)?

Does that mean that zooplankton respiration was increased in deep water after inflows, or that zooplankton necromass caused a respiration increase? I have a problem with the mass balance - how much zooplankton in terms of ratio to primary production and sinking flux is needed to make a difference?

717: What does that mean for the entire system? That GoF and northern areas function like a lake?

736: What does stagnant mean - no movement? Above you mention that small but frequent inflows supply more oxygen than MBIs?

747: stagnant?

776-780: Are these two statements not contradictory, because the lignin data are raised

on sedimentary POC?

811: Do sulfate concentration indeed persist below the disappearance of methane?

864: Why should the rates in permeable sediments of the shallow Baltic Sea be different from rates in permeable sediments of the North Sea (e.g., Hüttl-papers; Neumann et al., 2021)? There high rates due to advective transports into ripples are considerably higher than those for diffusive transports in impermeable sediments. Can you suggest any reason?

877: What does that mean: Are there hidden depocenters in shallow parts of the Baltic? Hard to believe that they have gone unnoticed or are large enough to make a difference....

939: The following paragraph is a general introduction to the carbonate system - is this needed?

976: announcement - put in outlook!

987-988 lower...higher: compared to what?

Fig. 8 caption: Give full names in legend

999: Is this relevant information in the context of this review?

1032: Unit?

1033: Is this last sentence important?

1051: Due to enhanced CO₂ assimilation?

1054: 1990's

1062: atmospheric

1064: ...various pH-reducing drivers work in the same direction, with natural weathering potentially counteracting (what? pH decrease?)

1064: large

Caption figure 9: It would be interesting to state the water depths of measurements.

1084: non-Redfield

1087-1088: on instead of at

Paragraph 2.7.1.: unclear how this related to biogeochemistry? Most references are older than period under investigation.

1012: What role do they play in matter cycling?

1165 ff: references are quite old

1199: How does the recent review paper differ from this one?

Section 2.8 (pollutants): This entire section is vague and holds no pertinent information

specific to the Baltic Sea. Metals and "old" organic contaminants are at the focus - wouldn't it be appropriate to include data on novel pollutants (I believe such data are available)?

Section 2.8.1: This again is in large parts quite general and not specific for the Baltic Sea, neither is the focus on progress in recent years....

Part 3: There has been a lot of planning for future research on national and international levels in the past years - how are the points raised here integrated and interlinked?

1349: This has been the case for the last 20 years - how can this shortcoming be remedied above all the data mining and modeling that has already gone into this?

1355: This as well has been a theme of intense research over decades already, hasn't it?

1368: There have been quite a lot of recent studies on DOM, if I am not mistaken?

1399: Accumulation or turnover? It seems unlikely that there will be significant depocenters, but rather intense turnover is very likely in sandy southern shallow-water areas and seems to be indicated by both observations and models.

1419 ff: This is certainly true, and not only in the Baltic Sea

1435: The Baltic Sea has "suffered" from anoxia over the last 8000 years. An eminent researcher once remarked: If you don't want the Baltic to be anoxic, well, build a dam!

1057: Who is G.H.? Not in author list?