Biogeosciences Discussions

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Comment on bg-2021-5

Anonymous Referee #3

Referee comment on "Deep-water inflow event increases sedimentary phosphorus release on a multi-year scale" by Astrid Hylén et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-5-RC3, 2021

Review of Hylen et al. Deep-water inflow event increases sedimentary phosphorus release on a multi-year scale

I found this paper to be clearly communicated and I appreciate the targeted focus of the study. I think the ability to capture a sediment-water flux response to a series of inflow events in the Baltic Sea is unique and the results are highly relevant to our understanding of the biogeochemical responses to eutrophication and oxygen depletion. The combination of in-situ sediment-water fluxes and porewater analysis (and supplemented by available monitoring) provides a sufficient dataset to explore the questions proposed by the authors. I do think some critical questions should be addressed in a revision of the paper, notably with respect to the impact of the seasonality of sediment-water fluxes, the ratio of DIC to DIP fluxes, and the balance between the inflows causing elevated organic deposition versus stimulating additional remineralization through oxygenation. I provide some specific and general comments below:

- I think Figure 1 is unnecessary. The main features of the feedbacks have been previously well described in the literature and the authors description of the feedback in the text is clear and adequate.
- Figure 2 – please specify the depths included to compute "bottom water" oxygen
- I think it could be stated in the paragraph in Line 120 that the prior fluxes (2008, 2010, and 2015) were performed using the same lander system as in the more recent fluxes.
- I would like the authors to enhance the discussion around the differences in sampling season between the earlier and later sediment-water fluxes. This is an important feature of the interpretation of the flux enhancement over time. Annual cycles of sediment-water fluxes in many temperate estuaries involve substantial seasonal variation. Is there a reason that a deep, typically anoxic basin should be different? Are the other datasets to cite from the literature? What about seasonal temperature effects? Could a reactive pool of organic material that may have accumulated during colder months be available by April, where if a spring bloom was important, perhaps this material would have been exhausted by late summer, when some of the other fluxes were measured?

- I appreciate that all of the flux rates (DIC, DIP, DSi, NH4) increased together in 2016-2017 at station F. But in reference to the Redfield ration, there were substantial excess DIP fluxes in 2016 to 2018. The authors consider this DIP excess but do not provide a clear explanation as I can see. The later discussion on elevated Mn oxide deposition might be relevant, as would Mn oxides scavenge P from the water-column preferentially? They also don't explore sufficiently why the DIC flux exceeds the DIN flux from a Redfield perspective, which perhaps is due to denitrification?
- In your conclusions, I think it is important to make a clear distinction between the inflows causing elevated POM flux and the inflows providing oxygen to enhance remineralization. If the former is more important, it would suggest that the inflow enhanced POM flux to sediments is the reason for the elevated sediment-water fluxes, and the oxygenation is simply associated with the inflow/flux in time. If this were true, it would dampen the argument that oxygenation might actually cause a transient enhancement of the "Vicious cycle"
- I was hoping the authors might come back to the idea of the "viscous cycle" in a discussion paragraph and clearly put their results in the context of that hypothesis. It has been shown that DIP concentration in bottom-waters is related to oxygen concentration in the Baltic – and this is cited as indirect evidence of the enhancement of sediment-water DIP flux under low oxygen. The supplementary data you provide on bottom-water DIP concentrations doesn't appear to show any enhancement of water-column DIP, even with the elevated rates you measured. Is this because the DIP-enhancement of sediment-water flux you measured only occurred in a limited area (although the up-scaling you did suggests it could be meaningful over larger scales). What if the April measurements are not representative of most of the year, as they are clearly higher than the previous years when measurements were made during summer? If the DIP flux enhancement is due to oxygenation, do your measurements suggest a timescale of this enhancement (1-2 years) given reoxygenation of an area? I realize this is a lot to digest, but I think a paragraph in the discussion that evaluates your results in the greater context of the cycle, citing the limitations of your measurements, would help the paper.