Biogeosciences

Discussions

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Interactive comment on "A Baltic Sea estuary as phosphorus source and sink" *by* Jakob Walve et al.

Anonymous Referee #1

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Reviewer comments

Summary Walve et al. (bg-2017-496) present an interesting study where phosphorus dynamics in an estuary in the Baltic Sea are quantified using a box-model approach. The study period spans from 1968 to 2015, and has a seasonal temporal resolution. Box model budgets for water and salt are calculated from measured freshwater inflow and salinity from two stations. These water budgets are further used to infer phosphorus fluxes to and from the study estuary. In general, the study comprises of a straightforward model exercise where abundant monitoring data has been used to build the model. One of the main findings is the identification of the sediment as a sink of phosphorus in spring and as a source during summer and autumn. Overall, the manuscript is well written and easy to follow.

General comments 1) A clear set of scientific questions and/or hypotheses are not presented. This renders the manuscript to resemble more a data report or a technical note. Also, the point of view is on one particular system, which makes the study very local, as generalizations that could apply to other systems are not presented. The manuscript would benefit from a clear formulation of scientifically relevant research question and/or hypotheses, which would potentially be relevant to other systems as well. 2) As pointed out in the study, there are multiple previous studies focusing on the phosphorus dynamics in this particular system (e.g. Karlgren and Ljungström, 1975; Karlsson et al., 2010; Rydin et al. 2011; Almroth-Rosell et al. 2016). This means that the novelty aspects of this manuscript should be emphasized more. What are the main discrepancies compared to other studies, and why adding one more model study of this system is justified? This justification is even more important, as the key finding (sediment as a sink for P in spring and as a source in summer/autumn) is also rather well understood phenomenon in coastal systems overall.

Specific comments

Note: line numbers should be continuous throughout the manuscript, not start again at the beginning of each page.

Title The title is very concise, maybe even too much so. The seasonality behind the source and sink actions could be introduced in the title already.

Abstract P1, L10: In effect, two box models are used in the study, and the box models are vertically layered. This should be made clear here as well. P1, L10: Here and elsewhere: there is inconsistent use of terms "box-model" and "box model". Authors should choose either one and use the same term throughout. P1, L20: Replace stores with pools or storages. P1, L23: Sentence is incomplete, contributed to what?

Introduction P1, L31-32: Sentence is vague and does not read well, please rephrase. P3, L1: Remove "coastal", as estuaries are by definition coastal. If estuaries are to be emphasized here, then the sentence should be rephrased. In general, estuaries

have short residence time in the mixed layer, but is that the case in the Stockholm Archipelago? I would assume that the stratification and the relatively deep basins lead to high water residence times in the water masses close to the bottom, compared to the fast water exchange in the surface layer. P3, L6: "deteriorated badly" does not read well, rephrase. P3, L32: Is this not the case with all box models, that they are dynamic? Or is this a special case of a "dynamic" box model? If so, it should be elaborated here. P3, L34: Should be "focused". P4, L1-4: See above; here I would expect to see a set of research questions, objectives and/or hypotheses which would clarify the aim of the study and also make it easy to follow throughout the manuscript if the goals are met in the study.

Methods P4, L7: should be "comprises of". P4, L20: Does this mean that temperature was measured from inside the sampling vessels? Please clarify in text. P5, L8-13: Why four layers? What is the justification of this number of layers and the depth ranges of those layers? Please elaborate. P6, L20: Replace at with during.

Discussion P13, L21: Replace scale with resolution. P13, L21: The reader should be reminded at this point what is 1A. P13, L22: "...and has poor long-term P retention..." does not read well, rephrase. P13, L26-27: When both models yield similar results in P budgets, what is the motivation to use both? If the poorer prediction of water exchange in the mean model is not important (indicating decoupling between surface and bottom water masses), then why include the boundary model at all? P14, L22: Replace yearly with annual. P14, L18-19: This is an important factor causing bias in sediment studies; in practice, most sediment cores are taken from sedimentation areas (local bathymetric depressions) where sedimentation rates are higher than in their surrounding area in general. This matter should be elaborated here. P15, L10-11: What is the the significant difference between the inner and outer part here? Why do you think that the polychates do not have an effect there? This should be elaborated here. P15, L13-21: So where does the TP in the upper layer go? It seems like sedimentation is suggested, but it is vaguely formulated and should be made clearer. P16, L14: Iron

obviously plays a major role in the P cycling in the sediments, therefore the iron fluxes and concentrations presented on page 17 should be brought up already here. This would better justify the lengthy discussion about the role of Fe in the system. P17, L15: Is this mean annual concentration? Should be made clear. P17, L19-20: Due to salinity differences between the surface and the bottom layers in the system, this is more like a rule than an exception, is it not? Therefore the assumption of water masses being well-mixed seems not justified. P17, L32: Replace yearly with annual. P18, L10: Here, P is presumed to be deposited as organic P. Why iron-bound (inorganic) P is not considered here, as it clearly is a significant pathway for P sedimentation as presented before.

Conclusions Overall, this section is too long and would benefit from shortening. Ideally, conclusions are a concise presentation of the key findings, which relate to the research questions and/or hypotheses presented earlier. For instance, the seasonality aspects could be the main concluding remarks.

Tables Table 1: Replace yearly with annual in the caption Table 2: Replace yearly with annual in the caption

Figures Figure 1: Sampling points can not be distinguished well enough from their background, so they should be made larger and with better contrast. Figure 4: These time series seem to have an increasing trend over the study period. This could be emphasized by plotting a regression line of some kind to the plots. This would also allow the quantification of the annual increase in observed values. Figure 5: In panel (c), the net values are hard to read because of the scale issue. For that reason, the net values should be shown only in the separate panel (d). The motivation to show also the values from the mean model in panel (d) is unclear.

End of review.

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