Biogeosciences Discussions

Biogeosciences Discuss., author comment AC1
https://doi.org/10.5194/bg-2021-113-AC1, 2021

Reply on RC1

Tianfei Xue et al.

Author comment on "Mixed layer depth dominates over upwelling in regulating the seasonality of ecosystem functioning in the Peruvian upwelling system" by Tianfei Xue et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-113-AC1, 2021

Dear reviewer,

We would like to thank you for your time and constructive comments, even though you do not recommend the manuscript for publication in its present state. Your comments will help us to improve the manuscript. They made us realize that we have to emphasize more clearly, and expand on the new aspects our manuscript adds to previous studies. Below, we add our responses to your general comments (in italics). A detailed point-by-point response to your detailed comments will follow at a later point.

C: *The authors do not really do justice to a previous paper (Echevin et al., 2008, hereafter EC08) that investigated exactly the same questions using a quite similar modelling approach. The latter is barely cited in the introduction and discussion, even though these authors conducted a comprehensive investigation of the factors driving the seasonal cycle of chlorophyll.*

R: We agree that we did not present the EC08 study as detailed as it deserves from the beginning, given that it is the main reference with respect to the controlling factors of the seasonal paradox that we analyse. It emphasizes the importance of the mixed layer depth in the seasonality of chlorophyll in the Humboldt Upwelling System. We will add a summary of what has been presented in EC08 in the introduction and refer to it more extensively in the discussion section.

C: *The material presented in this work provides very little new information with respect to the findings of EC08. The authors could have used their model to perform innovative sensitivity experiments (for example EC08 performed several sensitivity experiments to illustrate the impact of iron limitation, temperature, insolation on the seasonal cycle of chlorophyll) but here only one model experiment is analyzed.*

R: As noted above, we agree that we have not been clear about what our manuscript adds beyond EC08. Please find our two arguments below, namely (i) that we tested the robustness of EC08 with a different model, and (ii) that we expanded on their analysis and other existing studies by adding results on the ecosystem functioning.

Indeed, our results of what drives the surface concentrations of chlorophyll in the HUS corroborates the findings by EC08. Nevertheless, we find it of fundamental value to report that previous findings are robust against using a different model, in this case, BioEBUS instead of PISCES (used in EC08). BioEBUS model used in this study was developed explicitly for applications to EBUS and oxygen minimum zones [2]. In addition, we calibrated zooplankton in the BioEBUS model against observational estimates (something that is often omitted, despite the central role of zooplankton parameterizations on plankton dynamics [1, 3], as highlighted also by the reviewer in his/her comment to L73 of our manuscript). We aimed to assess if "biological" drivers, in particular grazing, play a role in the seasonality of chlorophyll, based on an analysis of the budget of phytoplankton biomass that allows for a quantification of the driving processes in the model. However, our budget analysis revealed that "biological" drivers were negligible compared to the biochemical argumentation already put forward by EC08. We will report on affirmative and new results in more detail in the revised manuscript.

In addition, as suggested by the reviewer (comment regarding the manuscript L314), we will include the evaluation of zooplankton and add results regarding the ecosystem functioning that we presently only briefly touched upon in the discussion. This will add one panel (see Figure 1 in supplement) to Figure 3 (in the manuscript), with total particulate organic matter showing a depth-time pattern similar to that of phytoplankton, and seasonality of export efficiency that closely follows the MLD. We will also add more details to the results and discussion section of how the seasonal paradox impacts ecosystem functioning, including phyto- and zooplankton composition, export and export efficiency since most of the sinking matter originates from the faecal material of mesozooplankton.

C: *They claim that they elaborate on the propagation of the seasonal cycle of surface chlorophyll onto higher trophic levels, but very few results are presented in the manuscript.*

R: Thank you for pointing this out. Please see also our response to the previous comment. We analyzed the seasonal cycles of zooplankton and export of organic matter but missed to appropriately include these results in the manuscript. We now realize that this is a shortcoming and would be happy to add detail on the ecosystem functioning in the results and discussion sections of the revised version.

C: *The second part of the paper, which compares different EBUS, is not particularly innovative in comparison to previous findings of Messíe and Chavez (2005,2015). It seems that the authors were inspired by these previous works but did not manage to expand on the scientific questions.*

R: Our motivation to compare different EBUS was to reveal how they differ in their relationship of mixed layer depths and upwelling, and how these distinct relationships possibly affect chlorophyll seasonality. While, to our understanding, such a perspective has not been taken previously, we agree that we discussed the correlations of the various variables across the EBUS too broadly without clearly pointing out existing knowledge and which novel aspects our perspective adds. We will shorten and streamline this section accordingly.

C: *English that needs to be thoroughly corrected.*

R: We apologize for the typos and incorrect grammar. We will pay thorough attention to improve the language in the revised manuscript.

References

[1] Thomas R. Anderson, Wendy C. Gentleman, and Bablu Sinha. Influence of grazing formulations on the emergent properties of a complex ecosystem model in a global ocean general circulation model. 87(1-4):201–213, 2010.

[2] Elodie Gutknecht, Isabelle Dadou, B Le Vu, Gildas Cambon, Joel Sudre, V´eronique Gar □con, Eric Machu, Tim Rixen, Annette Kock, Anita Flohr, et al. Coupled physical/biogeochemical modeling including o2-dependent processes in the eastern boundary upwelling systems: application in the benguela.Biogeosciences, 10(6):3559–3591, 2013.[3] A E F Prowe, M Pahlow, S Dutkiewicz, M Follows, and A Oschlies. Top-down control of marine phytoplankton diversity in a global ecosystem model.101:1–13, 2012.

[3] A E F Prowe, M Pahlow, S Dutkiewicz, M Follows, and A Oschlies. Top-down control of marine phytoplankton diversity in a global ecosystem model.101:1–13, 2012.

Please also note the supplement to this comment:
https://bg.copernicus.org/preprints/bg-2021-113/bg-2021-113-AC1-supplement.pdf