Biogeosciences Discussions

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Comment on bg-2021-113

Anonymous Referee #2

Referee 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-RC2, 2021

The authors investigate the mechanism associated to the seasonal variability of phytoplankton biomass in the upwelling system off Peru (PUS) based on a regional biogeochemical coupled model. Their focus in on understanding the apparent “paradox” associated with the fact that there is an out-of-phase relationship of seasonal surface chlorophyll concentrations and upwelling intensity, which is a unique feature of the PUS compared to the other Eastern Boundary Upwelling systems as they illustrate. Their model result indicate that minimum chlorophyll in austral winter during the upwelling season is mostly associated with the enhanced vertical dilution and stronger light limitation of phytoplankton biomass growth due to the deeper mixed-layer at that season. They estimate all the tendency terms at seasonal timescales of the rate of change in phytoplankton biomass (i.e. budget of the phytoplankton biomass) to quantify second-order processes (like reduced phytoplankton growth due to enhanced upwelling of cold waters and lateral advection). They then discuss their results in light of previous works and extend the discussion to implications for understanding net offshore export of phytoplankton biomass. This led us to hypothesize that mixed layer processes along the coast of certainly important for understanding ecosystem functioning.
The paper is interesting and has a sound methodological approach. It provides a synthesis of previous works dealing with this seasonal paradox and extends them nicely through a more in-depth analysis of the processes at work (i.e. detailed budget of phytoplankton biomass) and the broader scope though comparison with other EBUS. It is also well written a pleasant to read.

I have only minor comments mostly related to details in the methodology that I consider worth addressing considering that some results presented here are certainly somehow model-dependent.

Minor comments :

l.58-60 : QuickSCAT only cover the periods 1999-2008 so which wind forcing is used to cover the period 1990-2010 ? please clarify if this in an hindcast run or a climatological simulation.

l. 70-73: please indicate that the BioEBUS model was first used to simulate the Peru biogeochemistry by Montes et al. (2014)Montes I., B. Dewitte, E. Gutknecht, A. Paulmier , I. Dadou, A. Oschlies and V. Garçon, 2014: High-resolution modeling the Oxygen Minimum Zone of the Eastern Tropical Pacific: Sensitivity to the tropical oceanic circulation. J. Geophys. Res.-Oceans. 119, doi:10.1002/2014JC009858

l. 78-79 : "In this study, we use monthly output of the final five years for our analyses (years 26−30)" It is not clear with which forcing the spin-up is done and if is this is a repetitive selected year. Earlier it is mention that the simulation covers the period 1990-2010 so to which actual years correspond years 26-30?

Section 2.2.: It is not clear if all the terms associated to BIO are calculated on-line or off-line. If this is off-line, the use of monthly-mean mixed-layer depth for the vertical integration could yield errors that would be worth estimating. Mixed-layer depth can vary sharply at high-frequencies.

Figure 1: "Spatial distribution of the seasonality of surface chlorophyll" what is seasonality exactly? Amplitude of the annual cycle? Seasonality should be defined somewhere.

l.126, Figure 2: The region for averaging the data for the other EBUS is not defined (?). It should be indicated in the text of the caption for clarity. Please also indicate the results for the Chile EBUS.

Caption of Figure 2: "upwelling (estimated based on winds from QuikSCAT, in Sv" Do you mean from Ekman transport or Ekman pumping, or from both?. Please provide details on how upwelling intensity is calculated.

l. 154-156: "In other words, more nutrients only have a strong local positive effect if concentrations are low / would be low otherwise." This sentence is not clear; please rephrase

l. 163-165: "In the model, surface chlorophyll and nitrogen concentrations together with upwelling intensity and MLD all display a 40-60% seasonal variability" what is it meant by "40-60% seasonal variability"? Please clarify and rephrase.

l.194-195: “We separate biological processes (e.g. primary production, grazing from zooplankton, natural mortality, exudation, sinking) and physical processes (mixing, advection and entrainment) that affect the integrated biomass (Fig. 4b).” The detailed equation should be provided along with details on the method for integrating vertically within a seasonally varying mixed-layer. How do you calculate entrainment for instance?

l. 197-198: “Most biological and physical processes decrease from the start (t1) to the end (t2) of the decline phase (Fig. 4cd).” Biological processes should balance physical processes so when the former increase the later should decrease? We understand from figure 4b that physical processes were multiplied by -1? Could you please clarify and provide details in the text of the caption.
l. 272-273: “As we just argued in the previous paragraphs using the differences of the seasonalities of MLD and upwelling in the Peruvian.” Connect this sentence to the next one?

The discussion on the impact of global warming is a bit frustrating since it is only based on the implication of a reduced mixed-layer depth in the future. It could be extended to the expected changes in the tendency terms discussed in the paper.

Figure C4: “The correlation coefficient (R2=0.81) is shown for the decline phase” the correlation uses only 5 points so it is certainly associated to a low level of confidence?