

## ***Interactive comment on “Influence of intraseasonal eastern boundary circulation variability on hydrography and biogeochemistry off Peru” by Jan Lüdke et al.***

### **Anonymous Referee #1**

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#### General comments:

In this study, the authors analyse the alongshore coastal current intraseasonal variability and associated hydrodynamic and biogeochemical changes at 12S off the coast of Peru using in-situ measurements acquired during the mars-July 2017 shipboard sampling program. The manuscript shows some interesting results. It allows documenting the alongshore circulation during the propagation of a downwelling CTW mode 1 using real observations. The results are in agreement with recent modelling studies carried out over a longer period of time. Also, they look at the effect of the intensified poleward flow on the coastal hydrological and biogeochemical ocean properties. The

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major weakness of the paper is that the authors can't extract the intraseasonal variations from the interannual/seasonal variations using the ship measurements making the interpretation of the results more difficult. I would advise the authors to provide a more throughout discussion of their results using remote sensed data (when possible). Also, having a model study will back up their hypothesis. Finally, one additional issue is that the manuscript is sloppily written (sometimes hard to get the sense), with clumsy wording and need proper editing. I will try to give some examples of this below. I will suggest to proof-read the manuscript by a native English speaker. Also, the figures are of good quality but the captions need to be reworked. Sentences in the captions are too long and some basics information are missing (full dates, units etc...). Overall, I find the manuscript worthy for publication in Ocean Science, after a major revision. Please find below a list of comments followed the flow of the text, that the authors should address in the revised manuscript.

Specific/technical comments:

- 1) In the Abstract, what is meant by less fixed nitrogen loss? I am not a biogeochemist and so I might misinterpret what is saying here but in reading this part of the paper (and also the conclusion), I got the impression that the change in Nitrate was driven by changes in the rate biogeochemical processes. But, later on (in reading the results and the discussion), this does not appear to be the case?
- 2) l21-22: The introduction could be better structured and clearer. As an example try to define Peru Upwelling System (PUS) at the beginning of your introduction.
- 3) l22: Fig1: Too many details. Simplify to highlight only the surface and subsurface current mentioned in the text.
- 4) l34, l52: Be careful when defining acronyms to put the initial letter of each word in Capital. Re-check all over the manuscript.
- 5) l48, l65, l168: timescales (try to be consistent over the manuscript)

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- 6) I50-53: Explain more how local wind modulate the intraseasonal variability (upwelling intensity, local CTW..)
- 7) I52: Coastal Trapped Waves (CTW). Also, be consistent over the manuscript on the use of CTW or CTWs
- 8) I54: The sentence is incorrect, rephrase.
- 9) I55: Not reflected but transmitted. “Upon reaching the continental margin, part of the EKW bounces back along the equatorial waveguide into westward propagating equatorial Rossby waves, while part of incoming energy is transmitted poleward along the southwestern coast of South America as CTW”.
- 10) I56: Poleward propagating CTW modulate the alongshore and vertical currents
- 11) I59: The author should mention the influence of the CTW on SLA as sea level data are used in the Results’ section to track CTW
- 12) I60: this sentence is incorrect.
- 13) I62/63: The influence of remotely-forced CTW
- 14) I63: an individual propagating CTW
- 15) I67: Rephrase
- 16) In the Data section, the description of the ERSSTv5 data used in Figure 1 is missing.
- 17) I92- the investigation
- 18) I168- were smoothed
- 19) I will suggest to remove the position of the isopycnals from figure 2 and figure 3 as there are not useful for this section.
- 20) I209: Check the notation figure for Ocean Science: Fig. 2b and not Fig. 2(b)

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- 21) I208 Sea surface height anomaly / SLA?
- 22) I211: The author use  $\text{cm.s}^{-1}$  in the text. Change Figure to put the unit in  $\text{cm.s}^{-1}$  to be consistent.
- 23) I218: At these depths and offshore
- 24) I225: data were
- 25) I242: the meaning is unclear
- 26) I232: The alongshore current modal structure of the three first modes
- 27) I227: Need to add the values of the velocity of the climatological alongshore current (Chaigneau et al., 2013) in the text which are necessary for the demonstration of the intensification of the PCUC. Also similarly to Figure 6 and figure 8, I would suggest adding a third panel to figure 3 to show the difference between the two periods of the amplitude of the alongshore current.
- 28) I233: And the phase speed? Are they consistent with the theoretical values obtained in Illig et al 2018a?
- 29) I236-237: Wouldn't it be more accurate to compare the CTW modal structures to the alongshore velocities anomaly (i.e the difference between the 2 periods chosen)?
- 30) I255: remove the second "and"
- 31) I257: How are the zonal equatorial and coastal alongshore wind anomalies? Here the authors could add the intraseasonal variations of the winds superimpose to Fig5 or in another figure.
- 32) I258: suggests
- 33) Section 4.3 and 4.4: This section describes the cross-shore structure of the hydrographic and biogeochemical tracers to the PCUC intensification during the two selected period. The text is too detailed which make it heavy to read. I think the major problem

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with the writing overall is simply too many words. Please simply.

34) I264-265: You do not look at the processes in this study. Rephrase

35) I266-269: This is an example of sentences that could be shortened. Please rephrase

36) I277: I will found clearer to put the description related to the oxygen in section 4.4 (Response of the biogeochemical conditions to the PCUC intensification)

37) I285: Not many readers are familiar with the water masses characteristics off Peru. Please remind the reader what are the characteristics of the ESSW water masses (ESSW:  $T < 17\text{ }^{\circ}\text{C}$  and  $S > 35$ ; Silva and Neshyba, 1979; Chaigneau et al., 2013) in the text. Also, the authors may want to add a (small) panel with the position of the observations on a wider T/S diagram, with the T/S characteristics of the main water masses illustrated?

38) I267: dates on Figure 6 are wrong

39) I303: an increase of 5 ...

40) I358: The authors are looking at the total current vertical structure, not the anomaly.

41) I363: attributed to the second and third CTW modes. They found poleward velocities along the Peruvian.

42) I369: Could you explain how scattering will change the CTW vertical structure.

43) I371: the first CTW mode

44) I376: show

45) I378: alongshore winds

46) I383: the advection

47) I387-389: Total temperature/salinity cross-shore section during two periods (the

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initial phase and the peak of the poleward flow) along with the differences between the two periods are shown in figures 6a-f. Figures show an increase in temperature and salinity along the continental shelf under 100m, which is in agreement with the stronger transport/advection of warmer and saltier ESSW, poleward. The surprise is that negative “anomalies (differences between the two periods)” in temperature (Fig. 6c) and salinity (Fig. 6f) are found in surface. I agree with the authors, this might result from the interannual/seasonal variations that have not been filtered from the signal analysed. However, this part of the discussion could be further elaborated (see general comment above), by (for example) looking at the SST from the satellites data from which intraseasonal variations can be estimated.

48) I411: Does N-loss means biogeochemical processes? Could the authors re-specified which ones and clarify this sentence?

49) I412: Why would you expect this? Is the increase of Nitrate (and then, the reduce nitrogen deficit) not related to the stronger transport poleward in the PUS of high nutrient ESSW as shown by Echevin et al., 2014? You may want to re-specified (or show?) the mean Nitrate characteristics and provide the mean alongshore gradient of Nitrate to support your demonstration.

50) I423-425: the meaning is unclear

51) I432: It won't be the case if equatorial waters were less rich in nutrients than the PUS. The sign of the anomaly depends on the sign of current anomaly and the sign of the gradient of the tracer (temperature or biogeochemical variables).

52) I436: due to

53) I438: Do the authors see changes in the coastal ecosystem? I wonder if the nutrient input associated with the downwelling CTW and the change in the N-P ratio is associated with a phytoplankton bloom as describe in Echevin et al., 2014. Have the authors looked at satellites chlorophyll data?

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54) I442- suggests

55) I447- Again, at least, the small differences observed in temperature, salinity and oxygen could simply be due to the fact that the seasonal and interannual variations can not be removed from signal analysed. This statement is too strong for the conclusion.

56) I449/451: I do not think that was shown here (or at least not pointed out effectively). This study does not show changes in the rate of N-loss but rather point out the stronger transport of nitrate as the mechanisms for the nitrate/nitrogen deficit anomaly (in line with the results of Echevin et al., 2014). To look at how the biogeochemical cycles are affected by the CTW propagation further analysis are required (for example the use of a model). I will rephrase this to make your point clearer.

57) I452: "On intraseasonal timescales": From April to May 2017, our results suggest an increase in nitrate due to the passage of an intraseasonal downwelling CTW...

58) I453: A downwelling CTW?

59) I454 outcomes

60) I458: different from

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