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Interactive comment on "ENSO-driven fluctuations in oxygen supply and vertical extent of oxygen-poor waters in the oxygen minimum zone of the Eastern Tropical South Pacific" *by* Yonss Saranga José et al.

Anonymous Referee #1

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1 General comments

This article by Yonss Saranga José et al. describes a modelling study of the oxygen minimum zone (OMZ) in the Eastern Tropical South Pacific (ETSP). It foremost addresses the El Niño-Southern Oscillation (ENSO) driven variability of the OMZ vertical extent and analyses the responsible OMZ ventilation pathways. Conducting a hindcast run from 1990-2010 using the coupled ROMS-BioEBUS model, the authors find a thinning and deepening of suboxic waters (SW) during El Niño conditions, mainly due to

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lateral ventilation from sub-tropical waters, i.e. from the southern OMZ boundary. The results suggest a blocking of this ventilation pathway during La Niña conditions, which contributes substantially to the expansion of the SW layer during La Niña periods.

This interesting study follows the publication of a few other modelling articles on this topic, e.g. Mogollón and Calil (2017), Yang et al. (2017) and Espinoza-Morriberón et al. (2019). In contrast to the other studies, Yonss Saranga José et al. combines the analysis of the impact of ENSO on the ETSP OMZ on a large spatial scale (up to 750km off the coast) with elucidating the geographical origins of the ventilating water masses. However, as opposed to the mentioned previous studies, the mechanisms involved in the ventilation process (e.g. eddy vs. mean fluxes or the role of coastal trapped waves) remain untouched. The figures are of good quality, despite some need for clarification. Similarly, the manuscript is concise and written in a clear language. The content of this article is of relevance to the community, but the used methodology in not always conveyed in a clear way. I recommend this article to be published under consideration of these comments.

2 Specific comments:

2.1 Manuscript:

1. In the paragraph at the bottom of page 5 and top of page 6, the authors directly link the modelled long-term vertical expansion of the SW layer to the observed long-term expansion of the OMZ (Stramma et al. 2008) without further discussion. While Figure 2a,b suggests that the average modelled oxygen distribution has moved away from the initial climatological conditions, the authors do not provide evidence, that the model is fully spun up after 10 years of climatological forcing, and that the trend in the hindcast is not an artefact of model drift.

2. The concept of the “common volume occupied by the SW within the 1990-2010 time period” (page 6, lines 8-9) is crucial for the following analysis of ventilation pathways for the OMZ core. While this common volume seems to be constant over time, it remains unclear what shape this volume takes. Is it a cuboid with longitudinal and latitudinal lines as lateral boundaries and isobaths as upper and lower boundary? If not, i.e. if the boundaries of the common volume are slanted in space, how do you make the distinction between oxygen transports across the southern, northern, eastern, western, upper and lower boundary?âĂÍ Is it possible to plot the dimensions of the common volume? Further explanation is needed in order to convey the used methodology.

3. On page 6 beginning in the paragraph in line 16, the main ventilation pathways for the onshore and offshore region are discussed during normal conditions. The authors highlight the big role for the ventilation through the western margin with reference to the red lines in figures 6-a and 7-a. However, it is hard to see this large contribution in the mentioned plots. In addition, the contribution from other boundaries seems to be stronger than the transport through the western margin (e.g. the northern and southern margin). The discussion of the oxygen transport through the western margin remains also unclear in the following paragraph for the El Niño conditions.

4. On page 6, in lines 19 and 20, the transport of oxygen through the northern boundary is described as an efficient pathway for oxygen supply for both the onshore and offshore region. However, there seems to be an inconsistency as on page 7, lines 5 and 6, the oxygen transport through the northern boundary of the onshore region is stated to be predominantly northward, corresponding to the positive values of the blue line in Figure 6-b. A clarifying note on which way the oxygen transport through the northern and eastern boundary are defined would be helpful.

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5. In evaluating the mean state of the model the authors do not point out key differences between the observational datasets and the model output. As such, the mean oxygen distribution at 400 m depth in the ROMS-BioEBUS hindcast simulation shows almost anoxic conditions (O_2 < 5 mumol per litre) throughout the core OMZ, while the CARS dataset does not exhibit these low oxygen concentrations at 400m at all. âĂÍA further difference not pointed out are the zonal surface mean currents modelled offshore at 22°S, which is not featured in the observations.

6. While appropriately putting the study in the context of previous observational studies, this study misses out on comparing the obtained results with the previous modelling studies and discussing the differences (i.e. Mogollón and Calil (2017), Yang et al. (2017) and Espinoza-Morriberón et al. (2019)). The discussion of the manuscript should include this aspect.

2.2 Figures:

1. Fig. 1: A discrete color bar according to the contour levels would make a by eye comparison between model and observations easier. Are the x-axes for the panels c and d comparable to panels e and f?

2. Fig. 2: It would be helpful to have some labeled contour levels. From the provided color bar, it seems that the black contour levels in panel c and d mark the 10 mumol per litre isoline instead of the 20 mumol per litre isoline.

3. Fig. 3: In the caption the model is referred to as CROCO, whereas the labelling is stating ROMS. This should be consistent. Furthermore, I find the color coding of the plot lines in panel a not to be intuitive, even though it is well labeled. Intuitively, I would compare the red with the magenta line and the grey bars with the black line.

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4. Fig. 4: It seems that the upper and lower margins presented in Figure 4-e and f represent the spatial average over the entire extent of SW in the onshore/offshore region. What is the associated range of depths? Further, it might be helpful for readability to color the right y-axes and labels in panel e and f in red.
5. Fig. 5: In the caption the shown variables are described as “thickness of the suboxic waters [m] during (a) normal, (b) El Niño and (c) La Niña conditions.” While this implies some sort of composite distribution, the panels themselves state Normal (1998), El Niño (1997-1998) and La Niña (1998-1999), respectively. Clarify what is shown. Further state the shown variable and its units also in the figure (not just caption) for better understanding.
6. Fig. 6: Clarify that positive values for northward and eastward transport indicate a loss of oxygen for the SW layer (see one of the major comments).

3 Technical comments:

1. State what the model output time step is.
2. page 4, line 28, be more precise on where the in-situ measurements come from: oxygen variability recorded at 90-100m at 12°S along the Peruvian coast

4 Typos and language suggestions:

1. page 2, line 8: remain
2. page 2, line 32: nanophytoplankton or picophytoplankton
3. page 3, line 5: The model grid

4. page 3, line 10: wind from the CCMP
5. page 3, line 12: remote sensing systems
6. page 4, line 1: Peru Oceanic Current (POC)
7. page 4, line 1: Peru Coastal Current (PCC)
8. page 4, line 6: extends along the equator
9. page 5, line 3: defined here as waters
10. page 5, line 3: La Niña
11. page 5, line 31: suggests
12. page 5, line 33: addition
13. page 6, line 8: transport margins
14. page 6, line 9: consists
15. page 7, line 23: suggests
16. page 8, line 22: intermediate
17. page 8, line 23: has also been reported
18. page 8, line 25: supply varies
19. page 8, line 26: does not show any clear relation
20. page 8, line 29: suggests
21. page 8, line 33: The tropical pathway

22. page 9, line 1: suggests
23. page 9, line 4: path
24. page 9, line 9: pathway is an essential part
25. page 9, line 30: useful for the quantification
26. page 9, line 30: nutrient budgets
27. page 14, caption Figure 1: Peru Oceanic Current
28. page 17, caption Figure 4: Figure 5-a (in line 1)
29. page 18, caption Figure 5: (c) La Niña conditions
30. page 19, caption Figure 6: as well as (d) oxygen consumption
31. page 19, caption Figure 6: Rephrase the second sentence
32. page 19, caption Figure 6: Figure 5
33. page 20, caption Figure 7: The same as Figure 6

5 References:

1. Espinoza-Morriberón D, Echevin V, Colas F, Tam J, Gutierrez D, Graco M, Ledesma J and Quispe-Ccalluari C (2019) Oxygen Variability During ENSO in the Tropical South Eastern Pacific. Front. Mar. Sci. 5:526. doi: 10.3389/fmars.2018.00526

2. Mogollón, R., and Calil, P. H. R. (2017). On the effects of ENSO on ocean biogeochemistry in the Northern Humboldt Current System (NHCS): a modeling study. J. Marine Syst. 172, 137–159. doi: 10.1016/j.jmarsys.2017.03.011

3. Yang, S., Gruber, N., Long, M. C., and Vogt, M. (2017). ENSO driven variability of denitrification and suboxia in the Eastern Tropical Pacific ocean. Global Biogeochem. Cy. 31, 1470–1487. doi: 10.1002/2016GB005596

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