

Ocean Sci. Discuss., referee comment RC3
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Comment on os-2021-5

Anonymous Referee #3

Referee comment on "On the low western Pacific sea levels observed prior to strong East Pacific El Niños" by David J. Webb, Ocean Sci. Discuss.,
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This manuscript seeks to understand the cause and the physical processes behind the anomalously low sea level in the western North equatorial Pacific in the lead-up of the 1982/83 El Nino event. The author therefore makes use of a set of short (1 year) ocean model simulations with varying wind forcings and initial conditions. It is found that local wind anomalies in the central Pacific north of the Equator after April 1982 trigger Ekman divergence and hence cause a deepening of the North Equatorial Trough. The accompanying sea level gradient leads to an increase in the eastward NECC transport of warm waters supporting the development of a strong El Nino. The author further argues that this mechanism is based on prolonged westerly wind anomalies over several months and therefore provides an alternative to the classic Kelvin wave mechanism which relies on short term westerly wind bursts.

The study is novel and interesting and the methods use are applicable. However, there are various shortcomings in the presentation (mistakes in the writing, organisation of figures) that need to be rectified. Also, some more explanation for the author's reasoning is required at some instances. I encourage the author to revise the respective parts of the manuscript before I can recommend publication.

General comments:

26 figures for a paper with a relatively short story seem way too many. E.g., there is no need for 16 figures only for model validation. Why not validate the model with one or two timeseries averaged over selected regions and only show one map for one date and one year as an example?

In general, throughout the manuscript it would be very helpful for the reader to have all related panels closer together (e.g., in one figure) so they can be seen and compared at once without flipping pages. Also, difference plots would be very helpful for the model validation as well as in the results section. A lot of the figures can be merged together to one figure with more panels.

Another comment regarding the appearance of the figures. It should be made sure that all figures/panels are consistent among each other (e.g., same axis labels). Also, many (all?) axis labels and axis tick labels are very tiny and could be made larger.

Why is the author only focusing on the 1982/83 event and not also the 1997/98 event? It would be very interesting to know if the presented mechanism also applies to other strong El Nino events.

Section 1.2 seems unnecessarily long as it already goes into the details of the methods and even results. It could be condensed by leaving out all the details (shifting them to the Methods section) that are partly mentioned in the following sections and merged to the end of section 1.1.

There are multiple small spelling and grammatical mistakes (mostly missing words) throughout the manuscript. The manuscript should be carefully checked against such mistakes as it makes it harder for the reader to follow. I have started with a few in the specific comments below but they became too many to all list them here.

Specific comments along the manuscript:

line 25: Typo. missing "in" at the end of the line.

line 52: Typo. "started".

line 53: Typo. Missing "on".

line 74: word missing after "topography".

Figure 1: This figure can be made clearer. The two panels should be closer to each other and also be at the same height. Moreover, the y-axis and axis labels should be the same for both panels. It might also be helpful to add a difference plot as panel c. There are also several typos/missing spaces in the figure caption.

Figure 2: My comment to Figure 1 applies here, too.

line 113: Wrong figure reference. It should be "Figs. 3-6".

line 113: Why specifically these dates, 4th June and 2nd September? Probably related to the build-up and major phase of NECC transport. The author should explain/justify this.

Figures 3-6: Again, difference plots between Occam and Nemo would make it much easier to compare the variables.

Figures 3-6: In general, Occam seems to overestimate sea level variations as compared to Nemo. This should be mentioned in the discussion of the Figures. What are possible reasons for this? What impact on the results does this have?

line 135: "usefully used"?

lines 133-136: It should also be concluded that due to the lack of heat and freshwater fluxes Occam does not well capture the SST features (amplitude) of Nemo? How does this affect the usefulness of the model for this study?

lines 184-187: I am not sure I understand the reasoning here. Does the author really refer to the western Pacific rather than the eastern Pacific? To my ENSO understanding, the SST increases in the east, not the west, as a result of weakened easterlies/EUC. And the increase/decrease in sea level in the east/west is rather a result of changes in the water volume than of the density, although the temperature effect of course will also play some role.

lines 196-197: There are three grammatical mistakes in these two lines.

lines 198-203: Is this experiment necessary, after all, as the author has already shown in Figure 13 that the 1981 winds cannot produce a sea level low in the western Pacific?

line 207: This is not a very informative heading.

213-214: It is unclear to me how this statement contributes to the overall story presented in the manuscript. Please clarify.

Figure 22: Is panel a (left) really necessary as it was already shown before that the winds before 30th April do not play a role here.

Figure 23: Figure has neither a legend nor units.

Figures 25-26: Why is the Nemo output shown here instead of the Occam output?

line 256: I would say the Ekman divergence causes sea level changes, rather than Ekman pumping which causes isopycnal changes.

lines 262-264: What is the reason for this? Is it because of an increase in temperature as the El Nino develops?