

Interactive comment on “Transition to El Niño conditions in the eastern tropical Pacific in October 2015” by Lothar Stramma et al.

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Observed El Niño conditions in the eastern tropical Pacific in October 2015

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Michael McPhaden (NOAA) had a look at the original OSD manuscript and mentioned that the title is confusing. Therefore we modified the title as written above. He also proposed to give a brief opening paragraph about why it is important to study El Niño and as both reviewers especially reviewer 2 proposed to modify the introduction we

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introduced now an opening paragraph.

Reviewer #2: The authors report on changes observed during the strong Eastern Pacific 'El Niño' event developed in early 2015, and compare this event to previous similar events, neutral, and one 'La Niña-like' event. As expected from models and previous observations, the SSTs increase in the eastern equatorial Pacific, the surface salinity drops, the EUC and other equatorial currents weaken, and the thermocline deepens. As a consequence, the concentration of nutrients decreases, the concentration of oxygen increases, and the OMZ shifts deeper. The effects of 'el Niño' do not spread all the way to the southern station by October 2015, off the coast in Peru. I think that the paper is interesting and worth publishing, but I think that it would vastly improve if the writing is improved in some sections. There are several awkward sentences, and it is difficult to follow the flow of the paper if not an expert on the topic (especially the Introduction). I have minor comments mostly referred to organization and flow.

Answer to reviewer 2: We thank both reviewers for the helpful comments, which helped to improve the manuscript during the revision. We modified the manuscript as explained below in the detailed comments.

Reviewer #2: The abstract and the Conclusions contain almost exactly the same information. I would suggest reducing the abstract substantially (it is too long), and keeping the Conclusions section as it is.

Answer to reviewer 2: The abstract was shortened and the conclusion extended by shifting the end of page 15 to the conclusions as you proposed.

Reviewer #2: The Introduction is disorganized and difficult to follow. For example, changes due to climate change are discussed in Page2L5 and again in Page2L19. These should be discussed together. And before, the two types of el Nino should be explained. It makes it difficult to follow for non-experts. The description of indices in Page2L11 could go into Section 2 that could be called Datasets and Methods (or similar). If indices are discussed in the Intro, maybe not in the first paragraph.

Answer to reviewer 2: The order of the presented background information in the introduction was rearranged and the paragraph on the indices moved to the methods and called now as proposed 'Data sets and methods'.

Reviewer #2: I think that it is a good idea to move some of the Intro material into the mini-introductions in Section 4 and 5 (as it is), but the authors should avoid repetition with elements already described in the more general Introduction (Section 1). I suggest reducing the general Intro to avoid repetition, or put it all in the general Introduction (in which case you could include all the Seasonality changes together), or : : : (but avoiding the repetition of material).

Answer to reviewer 2: We shortened the detailed information in the introduction and presented the detailed information in the later paragraphs.

Reviewer #2: Supplementary Fig. 1 should be a main Figure as it is crucial to understand the whole picture (maybe together with current Fig. 1?).

Answer to reviewer 2: We moved the Supplementary Fig. S1 to the main text as Figure 2 and renamed the other figures accordingly. The region of this new figure 2 for the eastern Pacific is too small to integrate Figure 1 in a Pacific-wide figure to see the details of the different data sets used.

Reviewer #2: Could you somehow combine Fig. 3 and 4? (perhaps with irregular axis, with larger resolution from 0 to 100m).

Answer to reviewer 2: As there are large differences of the scales of oxygen, temperature, salinity and density in the upper 100 m and 100 to 400 m, a combination of both figures would lead to strongly reduced visibility of the changes related to the different El Nino phases. Hence we prefer to keep the two figures separated.

Reviewer #2:

Fig. 6 (add to the caption the date: : : October 2015, so that it's easier to follow without going back to text or Fig. 1)

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Answer to reviewer 2: We added the date of measurements as well as the velocity flow direction to the figure caption.

Reviewer #2: Specific Comments: Page1L11 “At the equator: : : October 2015” awkward phrasing

Answer to reviewer 2: This sentence was reorganized for better readability.

Reviewer #2: Page1L21 to L26 rephrase

Answer to reviewer 2: The shortening of the abstract as you proposed also led to a rephrasing of the former lines 21 to 26 on page 1.

Reviewer #2: Page2L4-5 rephrase Page2L5 “In contrast : : :” rephrase as for example ‘There has been evidence..., different from the common cold tongue, Eastern Pacific El Nino events: : : ‘ This sentence should come after describing the two types of El Nino. Why is it relevant to talk about the Modoki type if none of the described events fall into this category? (or maybe I missed something). If it is significant, comment on it in the Conclusions?

Answer to reviewer 2: The sentence was rephrased and shifted behind the general description of the ‘regular’ El Niño as proposed. As the Modoki El Niño is now often mentioned we like to introduce it briefly for readers not familiar with this difference although we do not investigate it in our manuscript. As reviewer 1 proposed to describe the Modoki El Niño with more references, we added a reference to an overview paper in Nature, but we did not expand the discussion further.

Reviewer #2: Page3L5 avoid repetition of EUC description with text later on the draft.

Answer to reviewer 2: The information on the EUC was shortened in the introduction and the detailed information was shifted to the later paragraphs.

Reviewer #2: Page3L18-25 “Oxygen increases as a result of circulation changes + explanation” This paragraph talking about oxygen needs more coherence and flow.

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The explanation about local winds is confusing and needs to be better linked with the following sentence (deeper thermocline) as it is counterintuitive. More upwelling but deeper thermocline? Etc: : :

Answer to reviewer 2: The information is added that the upwelling favorable winds could not produce the observed warming, but that warming is related to the downwelling Kelvin waves.

Reviewer #2: Are all the changes in oxygen due to circulation or are any of these due to reduced primary production (L26)?

Answer to reviewer 2: The additional influence of reduced primary production is now mentioned and a reference to Gutierrez et al. 2008 was added.

Reviewer #2: Page5L26 rephrase the sentence starting with ' Different: : : ' (suggestion: The SST distribution in fall 2015 shows a strong and prominent SST increase along Central America and in : : : that differs from the typical EP el Nino distribution.)

Answer to reviewer 2: The sentence was rephrased as proposed.

Reviewer #2: Page6L18 "The equatorial spreading of the thermocline: : : " rephrase and also explain what spreading of thermocline means.

Answer to reviewer 2: The sentence was from the original Johnson et al. 2002 paper. Now we included the information that the meridional spreading of the thermocline is related to the zonal EUC velocity strength.

Reviewer #2: Page7L8-11 rephrase paragraph? Not clear why salinity higher during EN events.

Answer to reviewer 2: This part was rewritten, removing the information on the late El Nino phase, which is not investigated in our manuscript and instead the reason for the higher salinity in the pycnocline due to northward progression of the salinity maximum of the South Pacific Tropical Water under the modified current bands during El Nino is

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explained.

Reviewer #2: Page8L4 “In October 2015: : : salinity lower because reduced equatorial upwelling: : :” and because increased precipitation?

Answer to reviewer 2: Right, the higher precipitation will be the major contribution and is now mentioned before the equatorial upwelling.

Reviewer #2: Page8L8 “In the profiles: : :” rephrase

Answer to reviewer 2: The part ‘In the profiles to 400 m depth’ was moved and the sentence rearranged.

Reviewer #2: Page9L3-8 What about March 1993? Oxygen is also high only in the high 60m: : : I would suggest to rephrase it so that it is easier to follow the author’s logics, and more clear. For example: The oxygen concentration was slightly higher only in the upper 60 m for both El Nino events in March 1993 and in October 2015 compared to : : : . However, earlier selected measurements: : : showed a clear oxygen increase to a depth of 350m, hence we conclude that el Nino influence on the water mass distribution: : : .

Answer to reviewer 2: We rewrote this text part as proposed.

Reviewer #2: Page9L20 “The modeled EUC transports: : :” are you giving some examples from OGCMs in the sentence before, or these are all the OGCMs used? Make it clear: : :

Answer to reviewer 2: Yes, these are OGCM examples from the ROMS model mentioned in the sentence before. This information is now included also in the sentence where the examples are given.

Reviewer #2: Page9L23 somewhat repeated information from the General Intro?

Answer to reviewer 2: The information on the EUC was shortened in the introduction and the sentence on p9 was removed as the major discussion is now in the conclusion

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paragraph.

Reviewer #2: Page10L6-9 this segment belongs to intro.

Answer to reviewer 2: This text was shifted to the introduction.

Reviewer #2: From Page13 onwards the writing flows much better: : :

Answer to reviewer 2: Ok.

Reviewer #2: Page14L5-14 I don't understand why nitrate was lower (contrary to El Nino expectations). Clarify in the text?

Answer to reviewer 2: Nitrate was actually higher in October 2015 compared to December 2012, as opposed to being lower. Under El Nino conditions upwelling is reduced, and this prevents nutrients such as phosphate and silicate from building up in the mixed layer, however, nitrate and nitrite are different because their distributions are driven more by oxygen availability which regulates nitrification and denitrification. The higher oxygen concentrations during El Nino events reduces fixed N losses and results in higher nitrate concentrations. We have now added this explanation in the text.

Reviewer #2:

End of page 15 You could move the summary of this sub-section (L18 onwards) into the conclusions.

Answer to reviewer 2: This paragraph was moved to the conclusions as proposed.

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