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Discussions

Interactive comment on "A Comparison of Ocean Model Results with Satellite Observations during the Development of the strong 1997–98 El Niño" *by* David J. Webb et al.

Anonymous Referee #1

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This study compares the simulation of the tropical Pacific by a high-resolution ocean model with available observations during the development of the extreme El Niño event of 1997-98. The motivation for this comparison stems from a previous study by the leading Author, who used the same ocean model to demonstrate the importance of the changes in the strength and temperature of the North Equatorial Counter Current (NECC) in the El Niño development.

I am not familiar with the previous paper by the Author, so that the mechanism by which the changes in the NECC at 5°N can produce large changes in the equatorial Pacific, where the largest SST and thermocline depth anomalies are ultimately found during

an El Niño, is not obvious from what presented in this paper. Although the mechanism may have been explained in depth in the lead Author's previous papers, to make this paper self-contained, more convincing arguments should be provided in this paper too, since the influence of the NECC on El Niño is the main motivation of this paper and guides all the diagnostics that are carried out by the Authors in this paper.

The mechanism for the development of an El Niño proposed by the Authors is an intriguing one, but in the strongly coupled series of events underlying the ENSO phenomenon, it is unclear how to identify causes and effects. During an ENSO event, the tropical Pacific undergoes a profound adjustment process, involving wind anomalies and wave propagation. In particular, anomalous warming in the equatorial Pacific causes a southward shift of the ITCZ with likely changes in the wind stress curl at the latitude of the mean ITCZ position. Changes in the NECC can be expected as a result of this adjustment, but it is unclear whether the NECC changes are actually the drivers of the El Niño development.

The Authors mention several time the annual Rossby wave. What causes this wave, why do they think that it is the main driver of the NECC changes, and why was the wave particularly strong in 1997? As mentioned before, Rossby waves in the tropical Pacific are the agent that allows the tropical ocean to adjust. Why so much emphasis on the annual Rossby wave?

The comparison between model and observations is very qualitative, except for the estimate of mixing in section 5. Much more could be done, including: 1) Support the interpretation of propagating anomalies as Rossby or Kelvin waves with an estimate of their phase speed; 2) Examine whether the changes in the NECC velocity, as estimated from the model, are consistent with the meridional gradient in sea level; 3) Compare SST and SSH hovmoeller diagrams to show that the warming seen along the equator is concurrent with equatorial Kelvin wave propagation, and 4) Estimate whether the changes in the strength of the NECC are indeed large enough to make an impact at 5N and along the equator.

Itemized comment, including typos:

1. Introduction, Lines 44-47. Why the deepening of the thermocline cannot produce surface warming? This should be briefly explained. 2. Introduction, Line 61. “where the” is repeated twice. 3. Section 1.1, line 3. How did the Authors assess that it was the “annual” Rossby wave to produce changes in the NECC? 4. Section 1.1, lines 25-30. The high sea level in the equatorial central Pacific discussed by Kug et al. (2009) only occurs during Central Pacific El Niño events. During Eastern Pacific events, like the extreme event consider here, the equatorial thermocline exhibits a very strong zonal dipole with deeper thermocline in the eastern Pacific and shallower thermocline in the western Pacific. 5. Section 1.2, Lines 53-55. SSH is important for its dynamical meaning, as it can be viewed as a proxy for thermocline depth and upper-ocean heat content. 6. Section 3, Line 26. Why was the annual Rossby wave unusually strong that year? 7. Section 3, P. 4, lines 12-16. In what way the chaotic nature of the waves is emphasized in difference plots? 8. Section 3, P. 3, lines 22-27. It is important to note that the two different stages of development of the 1997-98 El Nino have been related to different phases of Westerly Wind Burst (WWB) activity by several Authors (McPhaden 1999; Menkes et al. 2014; Capotondi et al. 2018, among others). How do the Authors reconcile the view they present in this paper with those previous studies? 9. Section 3.1, lines 42-44. The NECC can affect the ITCZ, but how is the perturbed ITCZ going to influence the warming in the eastern equatorial Pacific? 10. Section 4, line 43. How the “annual signal” was identified needs to be explained. 11. P. 6, lines 3-4. The increasing sea level in the west is typical of a developing La Niña, as it happened in 1998. 12. P. 7, line 40. I don’t think that we are looking here at a model prediction, but at a model simulation. 13. P. 8, line 21. “that” is repeated twice.

References

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Menkes, C. E., M. Lengaigne, J. Vialard, M. Puy, P. Marchesiello, S. Cravatte, and G. Cambon, 2014: About the role of Westerly Wind Events in the possible development of an El Niño in 2014. Geophys. Res. Lett., 41, 6476-6483, doi:10.1002/2014GL061186.

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