Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2020-77-AC2, 2020

Biogeosciences Discussions

Interactive comment on "Evidence of eddy-related deep ocean current variability in the North-East Tropical Pacific Ocean induced by remote gap winds" *by* Kaveh Purkiani et al.

Kaveh Purkiani et al.

kpurkiani@marum.de

Received and published: 25 June 2020

We thank the reviewer for carefully reading our manuscript and helping us to clarify the presentation of our results a lot. All corrections, modifications and explanations are given in red color lines in the text of our manuscript as well.

Responses to Reviewer #2 1. Section 3.1, the calculation of EKE is based on SSHA that is the deviation from the long-term mean. I think the "eddy" here is different from mesoscale eddies, as it includes seasonal and interannual variation, as well as mesoscale and submesoscale eddies. For example, there is a strong seasonal cycle in the mean circulations (e.g., Kessler 2006 The cir-

Printer-friendly version

Discussion paper

culation of the eastern tropical Pacific: A review, Prog. Oceanogr., 69, 181–217. https://www.sciencedirect.com/science/article/abs/pii/S0079661106000310) and the EKE in calculated here includes those signals. Since the focus is on mesoscale eddies, a filter that also removes seasonal cycle and low-frequency variability seems more appropriate (see, e.g., Chelton et al. 2007; Liang et al. 2012). These two papers are in the reference list of the manuscript).

As we are interested in the interannual variability of mesoscale eddies, related to ENSO events, we did not apply any filters to the SSHA (such as done in Liang et al.2012) to keep seasonal cycle and low-frequency variability. The SSHA are the daily mean data with removed any signals higher than a day originally.

2. Section 3.7, there are two papers (ENSO and Eddies on the Southwest Coast of Mexico.GRL (https://agupubs.onlinelibrary.wiley.com/doi/pdf/10.1029/2000GL011814; and Zamudio et al. 2006 Interannual variability of Tehuantepec eddies. JGR-Oceans (https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2005JC003182) about the relation between ENSO and eddy activities that were not cited. I would suggest the authors cite the papers and discuss how different the results in this study are from those papers.

The impact of ENSO events on the intensity and frequency of northerly winds at TT is more complicated and has been addressed in previous studies (e.g., Romero-Centeno et al., 2003; Zamudio et al., 2006). In contrast to the La Niña years during which winds are significantly weaker and the occurrence of northerly winds is significantly rarer, during El Niño years the more frequent occurrence of strong northerly winds is restricted only to May and September.

Despite the lack of a significant increase of suitable winds for mesoscale eddy formation at TT during El Niño years, a larger number of mesoscale eddies in agreement to our results is reported in this region in previous studies (Zamudio_2001, Palacios2005, Zamudio_2006). Thus, in contrast to the initial hypothesis, eddy formation and its interannual variability in the TT region cannot be solely explained by strong and intermittent wind events. The analysis of a high-resolution ocean model forced by ECMWF meteorological data from this region shows that an increase in propagating downwelling coastally trapped waves (CTW) during El Niño years plays a crucial role in the modulation and generation of TT eddies (Zamudio et al., 2006). While the CTWs propagate along the coast of Central America and Mexico, a strong horizontal and vertical shear of the horizontal velocity is generated, which can trigger barotropic and baroclinic instabilities. The breaking of long-wavelength CTW meanders generates mesoscale eddies in this region (Zamudio et al., 2006).

Please see section 3.7 in the MS for the further discussions.

3. When presenting statistics, I would suggest the authors add a significance level. For testing the hypothesis of no correlation the P-values are calculated. All the P-values for the Pearson correlation coefficients of TT and SR EKE are too small, indicating a significant correlation. This is added to the text at line 439. For the section 3.7 as we have used the annual mean of ONI and eddy characteristics, the calculation of P-values is most likely unrealistic.

4. Section 4.1, the bottom current <10 cm/s seems to be weaker than previously reported value (>15 cm/s) by Adams et al. 2011 (Surface-Generated Mesoscale Eddies Transport Deep-Sea Products from Hydrothermal Vents). This may deserve some discussions.

Thank you very much for pointing us to this interesting paper. In general, the paper supports most of our findings as well as the possibility of a seasonal cycle in deep-sea currents. The following discussion is added to our manuscript at line 370-390 in red.

The impact of surface eddies on deep sea current velocities in the NETP has been addressed earlier by Adams et al. (2006). The current velocities measured at depth of 2430 m from May to June 2007 at 9°50.0N, 104°17.4W show deep sea current velocity exceeding 15 cm/s during the sea surface height anomaly which is almost three times faster compared with the mean current speed of 5.5 cm/s at this region. The stronger current velocities observed in this study as compared to our measurements are likely due to the more significant impact of eddy on the deep sea due to shorter distance of eddy center from the mooring arrays, while our moorings are almost located at a distance of about 100 km away from the eddy center. Besides, the larger EKE of the young eddy and the shallower water depth in this region could be another resons for larger deep-sea current velocities. Due to the geographical location of the observations in their study, eddies in their stable life stage with relatively larger EKE content reach this region first. The shallower water depth at this region may also cause less energy dissipation in the ocean layers thus currents at deep sea content larger EKE. The lagging feature of deep ocean current response to the passage of a surface eddy observed in this region is similar to the results showed by Zhang et al. (2014) in the South China Sea (SCS) where they found a lag of 12 days between current velocities at the deep layer and the surface geostrophic velocity. The longer time lag observed by Zhang et al. (2014) can be related to the different water column stratification in SCS. These authors also showed that there are longer lags between the observed near bottom suspended sediment concentration and surface geostrophic velocities. Adams et al. (2006) also found that near-bottom current intensification is lagged the surface height anomalies by 8 days. Considering the water depth of approximately 2400 m in this study and 4100 m at the SR, the longer time lag of 15 days in our measurements between surface anomalies and the observed responses of the deep sea is shown to be linearly related to the water depth.

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2020-77, 2020.