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Comment

Interactive comment on “ENSO-correlated fluctuations in ocean bottom pressure and wind-stress curl in the North Pacific” by D. P. Chambers

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Thank you for your comments. I will review them briefly below and then give my response.

1. Comment: "1632-15: Since ECMWF winds that force the ocean model do not contain a trend (as it has been deduced from Fig. 11), the OMCT model cannot be expected to show a corresponding drop in OBP. The notion of the last sentence of the abstract should be therefore modified in order to make clear that forcing errors instead of model errors are responsible for this failure."

Reply: I had meant for the last sentence to be clear that there were likely forcing errors

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and not intrinsic model errors, but I will rephrase the sentence to read:

" Although this low-frequency fluctuation does not appear in an ocean model, we show that the winds used to force the model have a significantly reduced trend that is inconsistent with satellite observations over the same time period, and so it appears that the difference is due to a forcing error in the model and not an intrinsic error."

2. Comment: "1633-11: The rather technical term 'f/H contours' might be avoided by referring to the potential vorticity conservation requirement."

Reply: I will modify the sentence in the revision to say:

"The OBP variability is intensified in the western portion of the sub-polar gyre due to trapped modes caused by changes in bathymetry and conservation of potential vorticity"

3. Comment: "1636-2: It should be made explicit that OBP data considered at this stage of analysis are model based."

Reply: Reviewer # 1 was in fact confused by this and thought the analysis was on the GRACE data. I have modified the text at the begging of Section 3 to read:

"The leading EOF of non-seasonal WSC from the satellite data and OBP from OMCT over the North Pacific is shown in Figure 2. The spatial mode is similar to the pattern of seasonal variability for WSC, with the largest variations occurring just north and south of 35°N."

and also change the caption for Figure 2 to read:

"Figure 2. Leading EOFs (top) and principal components (bottom) of WSC from CCMP (left) and OBP from OMCT (right). . ."

4. Comment: "Please justify explicitly your choice of a multivariate ENSO index, which is rather seldomly used compared to, e.g., SOI or Nino 3.4, which are based on one single parameter."

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Reply: The main reason that I chose to use the MEI over the Nino3.4 or SOI is that it tries to include broader scale components related to ENSO other than the SST in the eastern Pacific, or pressure between two points (one of which does not actually lie in the center of the maximum pressure fluctuation). Moreover, the correlation between MEI and Nino3.4 or SOI is so high that it does not change any of the conclusions. I will, however, add a small statement regarding the choice of MEI in the section:

"We chose to use the MEI over other ENSO indices like the Nino3, Nino4, Nino3.4, or Southern Oscillation Index (SOI), as it attempts to use multiple parameters that are related to ENSO (SST, zonal and meridional winds, and pressure) over a broader area, as opposed to a single parameter in a small region. While the Nino and SOI indices were developed based on available limited older data, the MEI uses more large-scale observations and understanding of ENSO dynamics to create an index, and thus arguably gives better insight to the large-scale ENSO timing rather than the timing in only the eastern Pacific, which may lag or lead the larger pattern."

5. Comment: " Figure 4: Colors for 'El Nino' and 'WSC high' are not discriminable. Moreover, columns are referred to four different fraction of the year, making it difficult to read the figure. I suggest using only two timesteps for the two pairs 'El Nino' & 'La Nina' and 'WSC high' & 'low', respectively.."

Reply: Based on the comments, we have modified Figure 4. We are attaching a revised copy to this reply. First, we have split the figure into two portions: a) El Nino and WSC High, and b) La Nina and WSC low. This is mainly to remove the artificial gaps which made it appear that there were "4 fractions of a year", when in fact all were labeled with the same year. This allows the bars to lie next to each other in the same year. Additionally, we have changed the colors and textures of the WSC curves to make them stand out differently from the El Nino/La Nina bars.

The caption for the new figure is too long to plot below the Figure and is cut off. It will be:

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"December-January-February (DJF) averages of a) MEI during El Niño along with corresponding values of normalized ΔWSC where ΔWSC was high and b) MEI during La Niña events along with corresponding values of normalized ΔWSC where ΔWSC was low. Normalized values were computed by dividing by the standard deviation. Also shown are years where the normalized ΔWSC exceeded ± 1 , even if there was no El Niño or La Niña event. Note that the year indicated represents the year for January of the average. Hence, the 1997/98 El Niño is in 1998."

6. Comment: " 1639-20: should certainly read 'A_2 Mei(t)'"

Reply: You are of course correct. I have corrected this.

7. Comment: 1641-6: should read 'ENSO'.

Reply: Thanks. I have changed this.

8. "The conclusions might benefit from adding some thoughts on potential processes that might cause inter-annual wind variability in the North Pacific area besides processes related to ENSO. Since westerly winds primarily originate from the continental landmasses in Eurasia, WSC changes will certainly reflect atmospheric variability there"

Reply: Reviewer # 1 had a similar suggestion and I added this statement in Section 3.

" It should not be surprising that there are interannual variations other than ENSO in this area, since the Pacific Decadal Oscillation causes low-frequency changes in the winds over the area (Mantua et al., 1997; Qiu, 2003), and there is evidence of the PDO modulating the amplitude of ENSO events (Yeh and Kirtman, 2005)."

It is reasonable to include a similar statement in the conclusions, so I have also added:

"Our analysis indicates such low-frequency variations have occurred previously in WSC and OBP (Figure 10), but that the length of time for a complete oscillation between 1992 and 2003 was of order 4 to 5 years. The exact mechanism for these wind variations is

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not known precisely, although they are most likely related to the Pacific Decadal Oscillation, which is known to cause large, interannual fluctuations in the winds in the area, as well as cause (Mantua et al., 1997; Qiu, 2003), and has been shown to modulate the power of ENSO amplitudes in other regions of the Pacific (Yeh and Kirtman, 2005).”

Interactive comment on Ocean Sci. Discuss., 8, 1631, 2011.

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8, C628–C633, 2011

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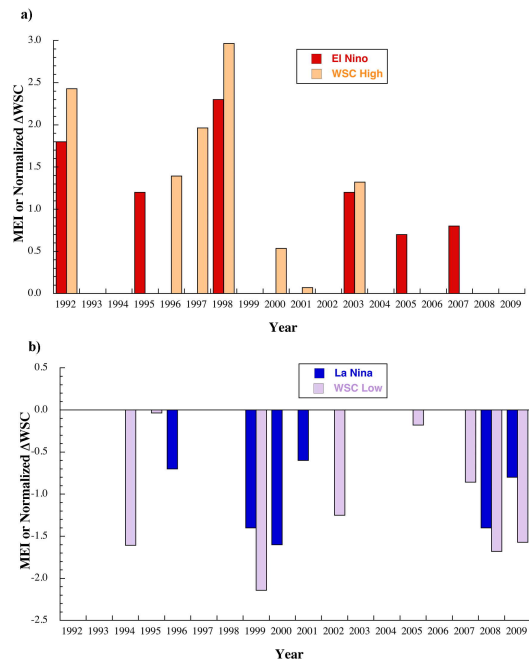


Fig. 1. December-January-February (DJF) averages of a) MEI during El Niño along with corresponding values of normalized ΔWSC where ΔWSC was high and b) MEI during La Niña events along with corresponding value