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Ocean Science Discussions

Interactive comment on "Joint effect of the western and eastern Pacific warm pools on ENSO cycle" *by* Q. Qi et al.

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The paper is concerned with the analysis of data from the Pacific covering the period 1950 to 2007. Gridded data of sea surface temperatures and 850 hPa winds are used to determine the eastern edge of the West Pacific Warm Pool, the southern edge of the East Pacific Warm Pool and their connections with the El Nino (NINO3 index) and the winds over the western, central and eastern Pacific.

I have a number of areas of concern:

1. The paper uses very long datasets and makes a number of points about the changes in climatology over this period. However the sources of data will have changed and this is not referred to. As an example, the early ocean data is probably based primarily

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on bathythermograph records and the sea water inlet temperatures measured by ships engine rooms - often made at the depth of a few metres. Much of this data will only have been available along the main sea routes. In the Pacific there may have been large areas each year without good data. Later XBT and satellite temperatures will have been added, satellites measuring temperatures in the top layer of ocean and doing so to the same accuracy over much larger areas of the ocean. Similar changes will also be found in the data used to determine the atmospheric fields.

Thus before discussing climatological changes the authors need to convince the reader that the effect of changes in measurement techniques and sampling has been allowed for and that they will not affect the results.

2. In many places the paper seems to assume that that the expansion and contraction of the warm pools implies movement of water. For example in the abstract (page 164, line 8) "the eastward extension of the WPWP .... can supply ... warm water into the NINO 3 region". In section 2.2 (page 169, line 8) "The WPWP and EPWP are two warm water engines." and "... the WPWP and EPWP shift ... . As a result ... warm water flows into the eastern equatorial Pacific and warms up the seawater ...".

However all that one can be sure of is that the region has warmed up. This is because of the Ekman induced divergence at the equator in the eastern Pacific (caused by easterly winds at the equator) and the westward flowing surface currents in the same region. Surface temperatures in the east are cold because of the upwelling. Heating from solar radiation and the atmosphere warms the water as it moves west or away from the equator. If the winds drop, as during an El Nino, temperature can rise because there is less upwelled water and the surface current is reduced. However the surface currents are still on average towards the west and away from the equator.

3. The paper also appears to confuse correlation with cause and effect. Thus in section 3.1 (page 171, line 16) having shown that there is are correlations between the wind and NINO 3 temperatures the paper these correlations "suggest that the zonal

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displacement of the WPWP was mainly forced by the wind anomaly". This is then followed by similar statements.

My point is that the correlations may support theories of how an El Nino develops but they do not prove the theories or prove new causes and effects.

4. I am also concerned why the paper includes a correlation with the meridional wind in the 'Northeastern Pacific' region without also including the zonal wind. Was this an oversight? At the equator a correlation of a zonal wind with a zonal current is reasonable, because the effect of the Earth's rotation is small in the equatorial wave guide.

In the east a correlation of the zonal winds near say 10 N might be considered physically reasonable, because the zonal wind will drive a northward Ekman current that will affect the position of the 28 degree isotherm. However a correlation with the meridional wind in the same area seems physically less likely - unless say it is involved in the upwelling in the Gulf of Panama.

A related point is the question of whether the average wind in the region is in any way independent of the wind at the equator. It is possible that essentially the same correlations would be obtained with winds at the equator. As the zonal wind here is responsible for equatorial upwelling, it is likely to have much more physical significance in understanding the overall El Nino problem.

5. My final main area of concern is where this is all leading us. The authors try and make the point (page 169, line 20) that in at least one case (1976) an El Nino appeared to be triggered primarily by an expansion of the East Pacific Warm Pool - although the case they make is not well argued partly because of the poor resolution figures (see below).

If this is correct then it is a really important point. The trouble is that in most cases, the expansion of the warm pools and the increased temperatures in the NINO3 region

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could all result from some general increase in temperature due to some, possibly remote, cause. As a result one should expect the correlations between measurements to be high anyway.

If some separate factor involving the East Pacific Warm Pool is important, then the best one might do within the statistical analysis is to show that a model (like Eqn.1), which takes into account data from both warm pools, gives a much better fit to the NINO 3 data than a model only involving one of the pools - after allowing to the extra degrees of freedom in the joint model. For linear models a statistical F test can be used to make this check.

Although the above comments are critical, I appreciate that the El Nino is still not fully understood and research still needs to be done on the different factors and mechanisms involved. The present paper tries to do this in a new approach making use of some long data sets from the region, and for that reason is to be commended. However the above points still need to be addressed before the paper proceeds further.

Other points:

Fig. 1 and 2: The discussion of these figures could do with a NINO 3 graph using the same horizontal scale. The mean position of the edges should be given in the caption or on the figure.

The horizontal scale is too cramped for provide any information concerning delays of a few months. A comparison of Fig. 1 and Fig. 4b (page 171, line 3) is impractical. There is a similar problem with the discussion of the 1976 events (page 169, line 20) but here a separate set of plots could be provided.

The figures state that these are 5 month running means of the data - so does each point represent the mean of the previous five months or is the filter centred about each data point?

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I did not find any similar statement in the text. Did the correlation analysis use 5 month running means? - in which case could apparent delays of a month or so be artifacts of the filtering scheme?

Fig 3. It would help if the paper also showed the position of the warm pool and wind anomaly regions used in the analysis as well as the NINO 3 region.

This figure also shows degrees east at all longitudes - whereas in the text the north-east Pacific wind region is 90 to 120 W. (Incidentally , most oceanographers consider the NE Pacific to lie north of 40 N. The paper needs another term for the eastern wind analysis region).

Interactive comment on Ocean Sci. Discuss., 5, 163, 2008.