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Climate of the Past Discussions

Interactive comment on "Implications of the permanent El Niño teleconnection "blueprint" for past global and North American hydroclimatology" *by* A. Goldner et al.

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General Note: The authors would first like to thank both reviewers for their helpful comments and suggestions to improve manuscript. Below we outline a general response to the reviewers with a detailed point by point response coming after the discussion closes and all specific comments will be integrated into the revised manuscript.

Specific comments in response to reviewers:

A general suggestion both reviewers made was to clearly outline which paleoclimate time period this experiment is trying to explore. The point of this experiment is to explain teleconnections over the mid-latitudes in Pre-Quaternary warm climate intervals.

Since there has been a specific focus in the literature to understand the Pliocene warm period we hope this study can be used to help characterize this period as well as the Miocene. The focus of the dynamical analysis is to explain precipitation changes over North America and the American west. Proxy evidence in these regions shows wetter conditions (Thompson, 1991, Thompson and Fleming, 1996, Smith, 1994, Smith et. al., 1994, Wolf, 1994) and a completely different vegetation cover with large forests (Axelrod, 1997, Wolf, 1985) whereas today many of these regions are semi-arid. It must be explicit that this study is a sensitivity experiment for exploring the scenario for why there was enhanced precipitation over central North America and other mid-latitude regions. There have been previous published fixed sea surface temperatures (SST) permanent El Niño sensitivity studies outlined in the manuscript which had different fundamental questions i.e Shukla et. al., 2009.

Another general suggestion from both reviewers was to clearly state which areas were wetter and drier in these Pre-Quaternary warm periods. The authors believe that this is a good point and will include a global and regional map of the model precipitation versus the proxy data. This figure will be introduced as a new figure 1 to set the stage for why we believe this is an important and relevant issue. The figure will also incorporate all the available literature on precipitation proxies for the Pliocene and Miocene.

There was a general concern about the model producing unrealistic precipitation anomalies due to the fact that the model may be in radiative imbalance because the simulation has fixed SSTs. The reviewer suggested that the simulations would not have this problem if they followed the methodology in Vizcaino et. al., 2010. The concern was based off the fact that in the text we mentioned a surprising result about the global mean temperature change scaled to the global precipitation change seemed larger than the Clausis-Clapyron relationship published in Held and Soden, 2006, and that the warm fixed SSTs may be causing unrealistic evaporative and latent heat fluxes.

The authors ran in addition to the permanent El Niño simulations a permanent La Niña simulation at varying resolutions (T31, T42, T85). The authors would like to show that the residual surface energy anomalies in both simulations reach +50 and -50 Watts/M2 (Figure 1). Indicating that the mean surface residual anomaly of -1.4 Watts/M2 is essentially a closed budget. The reviewers point is correct that the fixed permanent El Niño event causes a residual surface heat imbalance of -1.48 Watts/M2, but the results presented in Figure 1 show that the radiative imbalance that shows up in the permanent El Niño simulation is identical to a simulation with a colder permanent La Niña SST pattern (Figure 1a,b). When these two simulations are subtracted by each other the radiative residual surface energy is zero.

The atmospheric response to the SST changes are robust in the surface temperature (Figure 2,4) and precipitation anomalies (Figure 3,5) in the mid-latitudes in both the permanent El Niño and permanent La Niña simulations. Where we see increases in precipitation in mid-latitudes due to a permanent El Niño we see the opposite response in the La Niña simulation. In addition, the precipitation anomalies seen in the mid-latitudes in both simulations (Figure 3,5) are not affected by the small energy imbalance which is confined to a few grids cells in the equatorial region and the precipitation anomalies are spatially similar in simulations which produced a slightly reduced residual surface heat imbalance. When we compare our precipitation anomalies in the mid-latitudes to the anomalies in Vizcaino et. al., 2010, the results are spatially similar. We believe that if the permanent El Niño simulations were re-done with the ocean heat convergence approach seen in the Vizcaino et. al., 2010 study that the results would be the same, which is wetter mid-latitude regions in agreement with the Pre-Quaternary proxy record.

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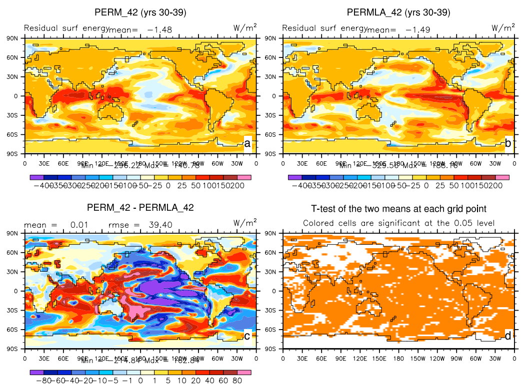

Figure 1. Residual surface energy(W/m²) for the permanent El Niño case(a), permanent La Niña(b), anomaly between permanent El Niño and permanent La Niña(c).

Fig. 1.

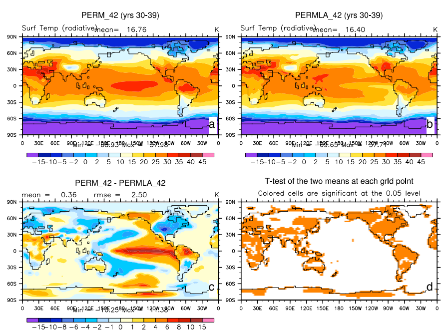

Figure 2. June, July, August (JJA) temperature (K) for the permanent El Niño case(a), permanent La Niña(b), anomaly between permanent El Niño and permanent La Niña(c).

Fig. 2.

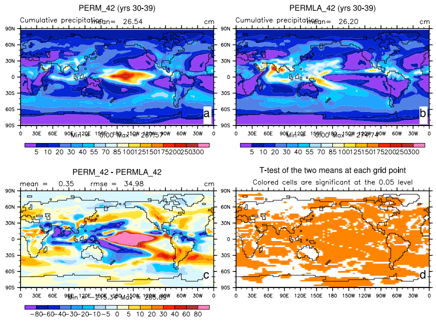

Figure 3. JJA precipitation for the permanent El Niño case(a), permanent La Niña(b), anomaly between permanent El Niño and permanent La Niña(c).

Fig. 3.

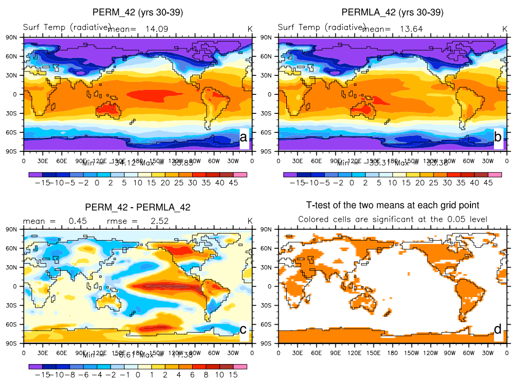

Figure 4. December, January, February(DJF) temperature (K) for the permanent El Niño case(a), permanent La Niña(b), anomaly between permanent El Niño and permanent La Niña(c).

Fig. 4.

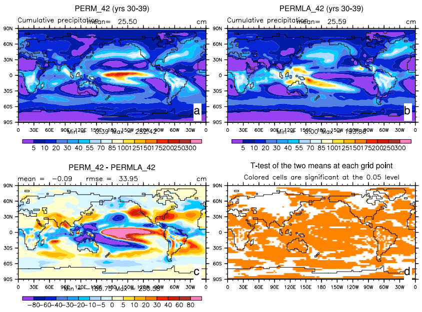

Figure 5. DJF precipitation (cm/year) for the permanent El Niño case(a), permanent La Niña(b), anomaly between permanent El Niño and permanent La Niña(c).

Fig. 5.