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Climate of the Past Discussions

Interactive comment on "Cold tongue/Warm pool and ENSO dynamics in the Pliocene" *by* A. S. von der Heydt et al.

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This paper is a nice contribution that advances the understanding of ENSO behavior in the Pliocene.

I don't have any comments on the modeling itself, but I have comments on the interpretation of the paleoceangraphic data. I think that the paper misrepresents, to some extent, what the data show with regards to constraints of the mean state, and of the variability during the early Pliocene warm period.

Existing published data, with the exception of two data points in the Rickaby and Halloran (2005) paper, from the east equatorial Pacific cold tongue during the early Pliocene, clearly show that the average temperatures were warmer than today. This includes

data from Wara et al. (2005), Dekens et al., (2007), and the highest resolution data record from the cold tongue from ODP Site 846 (Lawrence et al., 2006), as well as data from the PRISM3D reconstruction (Dowsett and Robinson, 2009; Dowsett et al., 2009). These data provide strong evidence for a reduced (but not absent) zonal temperature gradient (a mean state change), but do not provide any information, because of their resolution, on ENSO variability. However, new work by Watanabe et al. (2011), for example, shows ENSO variability also existed.

Therefore, I agree with RC631 that the authors have confused the concept of permanent El Niño-like conditions with permanent or perennial El Niño. For example, they state:

"the small east-west gradient prior to 2.7Ma has lead to the hypothesis that El Niño-like conditions were a permanent feature of the Pliocene climate rather than oscillating between La Nina and El Niño phases (Fedorov et al., 2006; Ravelo et al., 2006)."

However, El Niño-like conditions do not necessarily imply that ENSO (or any other scale of variability) did not exist. "El Niño-like conditions" describes the mean state of a reduced W-E gradient, while La Niña / El Niño oscillations describe interannual variability.

The following statement also demonstrates a misunderstanding of the basic paleoceanographic data:

"Within this framework, a "permanent" El Niño state would refer to a climatology with a small zonal temperature gradient which would be so stable that noise would not be able to excite any Niño variability"

Just to be clear, this definition of 'permanent' is formulated in THIS paper, and is not an accurate representation of previous work based on paleoceanographic data, which describes a reduced W-E SST gradient as a characteristic of the mean state.

In my view, the model simulations provide insight into the interplay between the mean

state and ENSO variability. The Pliocene paleoceanographic data, which as a whole show ENSO variability superimposed on a mean state with a warmer/reduced cold tongue, could be used to validate the model results. This paper seems to take the opposite approach; it uses the model to validate (or in this case invalidate) paleoceanographic data (however, it misinterprets the data to be indicative of reduced ENSO variability in the Pliocene).

One important observation regarding changes in the mean state of the tropical Pacific is that the subsurface temperatures were warmer (e,g, Wara et al., 2005, Ravelo et al., 2006, Steph et al., 2010, and see subsurface temperatures in Rickaby and Halloran, 2005). Again, this appears to be a mean state change, and a potentially important clue as to why the average sea surface temperatures were warmer in the cold tongue during the early Pliocene. It is also an observation that, it seems to me, could be directly used to validate the model simulations.

The idea that the 'cold tongue' could have moved west is an interesting one, and provides a concrete idea of how the limited geographical range of Pliocene data could be a problem. (Although note that the PRISM3D equatorial Pacific dataset includes only one data point outside of the present day cold tongue, at about 133 W, which indicates no change in temperature, and that the PRISM equatorial SST profile shown in Fig 7 is based on no equatorial data between 95 and 133 W). In any case, I think this paper could be improved if it provided some deeper insight into limitations of the model that might explain why it fails to reproduce the paleoceanographic evidence for a mean state with a reduced zonal gradient together with ENSO variability similar to today. This could provide a roadmap for both for modeling and observational work in the future.

Overall, I think this is an important contribution, worthy of publication in 'Climate of the Past' once the explanations of the paleoceanographic data are more accurate. Thank you for the opportunity to comment on the manuscript.

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