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Climate of the Past Discussions

Interactive comment on "Madagascar corals reveal Pacific multidecadal modulation of rainfall since 1708" *by* C. A. Grove et al.

Anonymous Referee #2

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This paper presents a 300 year climate archive based in Madagascan corals and attempts to use this information to test the hypothesis that the Pacific Decadal Oscillation (PDO) is a primary driver of multi-decadal variability in the Indian Ocean. The objectives of the paper are well warranted and the question of Indian Ocean multi-decadal variability is if great importance if we are to put long term anthropogenic climate change in context. The paper is well written; although I do have a problem with some of the text being in first person, in particular the use of "our", because scientific literature tends to be written in 3rd person (however I guess this is up to the editor).

While the analysis presented is very interesting, there are some serious problems with the methods and conclusions reached which need to be addressed before publication of this work. I do believe this is a worthwhile piece of research and I hope that the

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comments outlined below will help strengthen the revised paper.

Major comments: 1. The major concern I have with the paper is the use of only one reconstruction of the PDO on which to test the author's hypothesis that the PDO is a driver of Indian Ocean variability. Not only do the author's only test one proxy PDO record (when at least 6 separate reconstructions are available), they chose a PDO reconstruction that represents the large-scale Asian expression of this phenomenon. The authors of this reconstruction (D'Arrigo and Wilson 2006) actually admit that the proxy Asian PDO record is influenced by local climate from the Asian monsoon and volcanic forcing and therefore is not a true representation of the PDO, rather a mix of the PDO signal and local climate variability. The legitimacy of this reconstruction in representing the PDO is also question by the fact that it is very different to other PDO reconstructions based on North American paleodata (see figure attached comparing 4 different PDO reconstructions (including D'Arrigo and Wilson, 2006) and associated correlation matrix.

As you can see by the attached figure the D'Arrigo and Wilson PDO is very different from the other three proxy PDO records (which bear much more similarity to each other). I suggest that in order to truly test the impact of the PDO on Indian Ocean SSTs the author's should repeat their analysis using the other PDO reconstructions to verify their results. Otherwise what they might be picking up in their trend analysis is a relationship with variability in the Asian Monsoon rather than Pacific Ocean variability and this would lead to a very different conclusion than the one presented in the paper.

The introduction could also benefit from a short review on the various reconstructions of the PDO (see Verdon, D.C., and Franks, S.W. (2006) Long-term behaviour of ENSO – Interactions with the PDO over the past 400 years inferred from paleoclimate records, Geophysical Research Letters, 33(6), L07612, doi:10.1029/2005GL025052 for a starting point but needs to be updated to include more recent proxy records)

2. A literature review on the relationship between PDO and rainfall patterns (last 3

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lines of introduction) is lacking. There is quite a few papers that should be referenced here including: a. Kiem, A. S., and S. W. Franks (2004), Multi-decadal variability of drought risk - Eastern Australia, Hydrological Processes, 18(11), 2039-2050. b. Kiem, A. S., S. W. Franks, and G. Kuczera (2003), Multi-decadal variability of flood risk, Geophysical Research Letters, 30(2), 1035, 10.1029/2002GL015992. c. Power, S., T. Casey, C. Folland, A. Colman, and V. Mehta (1999), Inter-decadal modulation of the impact of ENSO on Australia, Climate Dynamics, 15(5), 319-324. d. Verdon, D. C., A. M. Wyatt, A. S. Kiem, and S. W. Franks (2004b), Multi-decadal variability of rainfall and streamflow - Eastern Australia, Water Resources Research, 40(10), W10201, doi:10.1029/2004WR003234.

3. The IPO is mentioned in the paper on line 25 without the authors explaining the meaning of the acronym. It is also suggested that the authors discuss the IPO and related literature and how it differs/or is similar to the PDO.

4. It is not clear how the observed rainfall and temperature data sets for Antongil Bay are used to calibrate the paleomodels of climate? These records are very short (only 4 years) and therefor are not long enough to assess any relationships. The authors use various indices of climate (Sr/Ca, Ba/Ca, G/B) but don't actually show any evidence that these are surrogates for rainfall or runoff. The authors state that the G/B ratio is representative of runoff in the catchment relating to rainfall variability, but how was this assessed? What runoff data was used to confirm this? How strong was the relationship? This all needs to be clarified in order to support the conclusions made by the authors.

5. To strengthen their argument the authors need to discuss the physical mechanism that explains why the Pacific might drive Indian Ocean variability on a multi-decadal timescale. That is they need a more in depth discussion of how the PDO might influence Indian Ocean and summary of relevant literature. Another issue worth discussing is the fact that the mid-1970's shift in SSTs is clear in both the Pacific and Indian Ocean records, however the 1940's shift is not as obvious in the Indian Ocean (see Samual,

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J.M, Verdon, D.C., Sivapalan, M. and Franks, S.W. (2006) Influence of Indian Ocean sea surface temperature variability on Southwest Western Australia winter rainfall, Water Resources Research, 42, W08402, doi 10.1029/2005WR004672.).

6. The authors state that eastern Madagascan rainfall should decrease as the PDO is currently transitioning to negative. However, as the authors state in the introduction, the IPO negative phase started in 1998 (best estimate) so a discussion (perhaps graph) of rainfall in the region in recent years would be useful in order to test the theory. Has rainfall been lower than average in the past 14 years?

7. The authors conclude that they have provided evidence that Southwest Indian Ocean rainfall is linked to the PDO, however this is based on evidence from just one region (NE Madagascar). Therefore this could just be a regional phenomena and it may not be appropriate to generalise this result. Fig D1 shows that Madagascan rainfall is correlated to the PDO, but this relationship is not observable for South-east Africa. It may help if the authors use a gridded rainfall data set that includes rainfall over the oceans as well as land (e.g. CMAP) to reproduce Figure D1 as this would help assess areas in the Indian Ocean that are correlated to the PDO (In addition to Madagascar). This plot should also be in the main paper rather than in an Apendix. Also why do the authors use a May to April window in calculating correlations between global precipitation and the PDO when all other annual analysis presented in the paper is based on a calendar year (Jan-Dec)

8. The authors state in their concluding sentence that “The widespread operation of the Pacific multi-decadal modulation recognised here provides new constraints for future rainfall patterns on human timescales that will assist water management, soil conservation and biodiversity programs. . .” However, even if the PDO is indeed a driver of rainfall variability in tropical Indo-Pacific, as yet the PDO cannot be predicted. So how then would the PDO information be used in this sense? The authors need to elaborate here.

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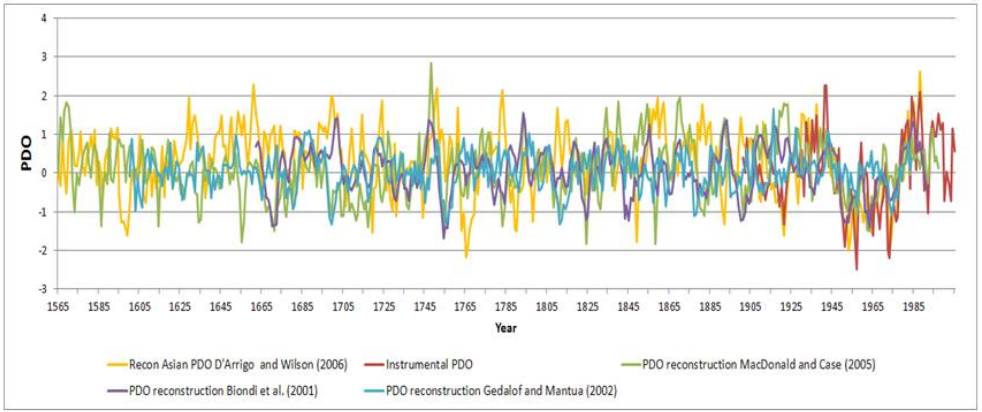

	Recon Asian PDO D'Arrigo and Wilson (2006)	*Instrumental PDO*	*PDO reconstruction MacDonald and Case (2005)*	*PDO reconstruction Biondi et al. (2001)*	*PDO reconstruction Gedalof and Mantua (2002)*
Recon Asian PDO D'Arrigo and Wilson (2006)	1.00				
Instrumental PDO	0.70	1.00			
PDO reconstruction MacDonald and Case (2005)	-0.02	0.34	1.00		
PDO reconstruction Biondi et al. (2001)	0.14	0.48	0.56	1.00	
PDO reconstruction Gedalof and Mantua (2002)	0.00	0.52	0.16	0.18	1.00

Fig. 1. Comparison of PDO reconstructions

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