Ocean Sci. Discuss.,
https://doi.org/10.5194/os-2019-30-AC1, 2019

Ocean Science
Discussions

Interactive comment on "The Pacific-Indian Ocean Associated Mode in CMIP5 Models" *by* Minghao Yang et al.

Minghao Yang et al.

240833134@qq.com

Received and published: 18 September 2019

We thank the reviewer for the constructive comments that help improve the presentation of the original manuscript. Below are our point-to-point replies to the reviewer's comments (original comments are in italics):

Please see the PDF version in the Supplement.

Main points:

1. The only reference to the Pacific-Indian Ocean Associated Mode I can find is related to a few publications by the authors themselves. Essentially, what is meant by this Mode is the well-known teleconnection between the Pacific (ENSO) and the Indian Ocean. Unfortunately, this study even fails to take the seasonality of this teleconnection

Printer-friendly version

Discussion paper

into account. For example, in boreal winter the main mode of variability of the Indian ocean (the basin mode) is forced by ENSO, whereas in summer and autumn the response of the Indian Ocean to ENSO projects onto the IOD (which is the focus of this study). However, this seasonality is important but not addressed at all. For example, this basin mode can be seen in Fig. 1, whereas the IOD response may be identified in Fig. 6. To not consider this seasonality makes the study essentially useless.

Reply: Thank you for your comment very much. We followed the suggestion that seasonality is needed to be considered, and thank the specialist for precious advice. The Pacific-Indian Ocean associated mode (PIOAM), defined as the first dominant mode (empirical orthogonal function, EOF1) of SST anomalies in the Pacific-Indian Ocean between 20°S and 20°N. Figure below shows the pattern of SST anomalies over the Indo-Pacific Ocean in October 1982 and September 1997. It can be clearly seen that there are obvious warm tongues in the eastern equatorial Pacific Ocean, obvious positive SST anomalies in the northwest Indian Ocean, and obvious negative SST anomalies in the western equatorial Pacific Ocean and the eastern Indian Ocean. This is precisely the typical spatial pattern characteristics of the PIOAM. That is to say, the SST anomalies in the northwest Indian Ocean and the equatorial middle-east Pacific Ocean is opposite to the SST anomalies in the western equatorial Pacific Ocean and the east Indian Ocean. Compared with ENSO and IOD, the PIOAM has a broader spatial distribution.

Maps of SST anomalies for (a) October 1982 and (b) September 1997 from the HadISST dataset (unit: âĎČ). The period from 1981 to 2005 is used to extract the monthly SST climatology.

However, is this spatial pattern of SST anomalies only a special case of a certain year, or is it stable? To answer this question, EOF analysis is performed on the SST anomalies of different seasons over Indo-Pacific Ocean (20°S-20°N, 40°E-80W°) from 1951 to 2005. All these first leading modes in Figure below are well separated from the remaining leading modes, based on the criteria of North et al. (1982), which means less likely to be affected by statistical sampling errors. It can be found that the patterns of summer (June, July and August; Figure below b) and autumn (September, October and November; Figure below c) display the typical spatial distribution of the PIOAM, with the 46% and 61% contribution to total variance, respectively, while the spatial pattern of PIOAM is not so obvious in spring (March, April and May; Figure below a) and winter (December, January and February; Figure below d). In general, the PIOAM has stable structure and practical significance, especially in autumn.

Spatial patterns of the first leading mode of the (a) spring (March, April and May), (b) summer (June, July and August), (c) autumn (September, October and November) and (d) winter (December, January and February) averaged SST anomalies over Indo-Pacific Ocean (20°S-20°N, 40°E-80W°) calculated from HadISST dataset (unit: âĎČ). The numbers at the upper right corner of each panel indicate the percentage of variance explained by each season.

In addition, based on multi-variable empirical orthogonal functions, Chen and Cane (2008) and Chen (2011) also found this phenomenon and named it Indo-Pacific Tripole (IPT), which is considered to be an intrinsic mode in the tropical Indo-Pacific Ocean. In addition, Lian et al. (2014) used a conceptual model to discuss the development and physical mechanism of the IPT. Yang et al. (2006) found that the influences of the PIOAM and the ENSO mode on summer precipitation and climate in China were very different, and their numerical experiments also showed that the simulation results obtained by considering the PIOAM were more consistent with observation data. Therefore, evaluating and improving the capability of current climate models to simulate the PIOAM are beneficial to obtain accurate climate predictions.

Reference:

Chen, D., Cane, M. A.: El Niño prediction and predictability, J. Comput. Phys., 227, 3625-3640, doi: 10.1016/j.jcp.2007.05.014, 2008.

Chen, D.: Indo-Pacific Tripole: An intrinsic mode of tropical climate variability, Adv.

Geosci., 24, 1-18, doi: 10.1142/9789814355353_0001, 2011.

Lian, T., Chen, D. K., Tang, Y. M., Jin, B. G.: A theoretical investigation of the tropical Indo-Pacific tripole mode, Sci. China-Earth Sci., 57, 174-188, doi: 10.1007/s11430-013-4762-7, 2014.

North G. R., Bell, T. L., Cahalan, R. F., Moeng, F. J.: Sampling errors in the estimation of empirical orthogonal functions, Mon. Wea. Rev., 110, 699-706, doi: 10.1175/1520-0493(1982)110<0699:seiteo>2.0.co;2, 1982.

Yang, H., Jia, X. L. and Li, C. Y.: The tropical Pacific-Indian Ocean temperature anomaly mode and its effect, Chin. Sci. Bull., 51(23): 2878-2884, doi:10.1007/s11434-006-2199-5, 2006.

2. The ad-hoc definition in Eqs. 1,2,3 is not good enough. The common Indo-Pacific mode should be identified by an EOF analysis.

Reply: Thank you for your comment very much. It is customary to select the time coefficient (PC1) of the PIOAM as its index. It can be seen from the regression of the monthly SSTA onto the normalized PC1 (Figure below a) that the pattern in the Pacific Ocean is similar to ENSO, but positive SST anomalies occur throughout the Indian Ocean, which not matches the typical PIOAM spatial pattern. This is because the ENSO signals in the Pacific Ocean in PC1 are so strong that the signals of the IOD are not fully reflected. The correlation coefficient between PC1 and Niño3.4 index is as high as 0.95. However, obvious negative SST anomalies in the eastern Indian Ocean can be found in the regression map of the monthly SSTA based on the normalized PIOAMI (Figure below b) defined by Eqs. 1, 2, 3. The correlation coefficient between PIOAMI and Niño3.4 index is 0.68, indicating PIOAMI contains more Indian Ocean signals than PC1. In addition, the correlation coefficient between PC1 and PIOAMI is 0.70, which is far more than the confidence level of 99%. Therefore, PIOAMI can describe the mode well because of giving consideration to both the signals in the Pacific Ocean and the signals in the Indian Ocean.

Regressions of the monthly SSTA onto the normalized (a) PC1 and (b) PIOAMI for the period from 1951 to 2005 (unit: âĎČ). The stippled areas for SSTA denote the 99% confidence levels.

3. There is no in-depth analysis as to why the models do or do not represent the mode. Section 4 is pure speculation. The fact that some models including carbon cycle simulate the mode slightly better does not proof anything, if not supported by a large number of models, or by dedicated experiments.

Reply: Thank you for your comment very much. We think your suggestion is correct and delete the Section 4 which is based on most of the speculation. The abstract and discussion are also be revised.

Please also note the supplement to this comment:
https://www.ocean-sci-discuss.net/os-2019-30/os-2019-30-AC1-supplement.zip

---

Interactive comment on Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-30, 2019.