

## ***Interactive comment on “Transition process of abrupt climate change based on global sea surface temperature over the past century” by Pengcheng Yan et al.***

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Dear Referee,

We appreciate your interest to our article. As your noticed, the method was published in this same journal, and this manuscript is a following work. In the previous paper, a novel method was proposed and applied to the Pacific Decadal Oscillation index. It's true that the index states “a system that are continually changing its behaviour between positive and negative states”. By applying the detection method, several abrupt changes were verified. In the reference(Yan et al, 2014), this method was used to study the transition process of 500 hPa temperature field. That result exposed a new statistical characteristics of the abrupt climate change.

C1

And for the comments, we reply on them as follows:

1.Referee. PDO index synthesize the collective behaviour of an extended area of the ocean. But having a great number of series varying we can randomly detect a possible abrupt climate change that is not real in a single point of the ocean. To avoid this possibility authors put a threshold of 1% of the points performing this abrupt changes. Nevertheless the value of SST of one grid square is not independent of the value of the SST of neighbouring grid squares. Therefore I suggest to made an interdependence test to calculate this threshold. This can be done by replacing SST series with a Gaussian noise series generated from a normal population whose mean and variance are identical to that of the series over the whole studied period, examining abrupt changes in these series and repeating the process a number of times equal to the number of grid points. In this way the number of abrupt changes can diminish and the results could be more representative of real abrupt changes.

Authors. As shown in figure 1(appendix), a numerical experiment is used to test the threshold. According to referee's suggestion, each original SST series is replaced by a new time series which is rebuilt by shuffle algorithm. The new time series is random, and its mean/variance is identical to the original one. Then, by detecting the abrupt changes of new series, the frequencies of start moment and end moment like figure 1 of manuscript are displayed. There is no moment at which the frequency is more than 1%. Another 10 experiments(the calculation cost 10 hours for each experiment) are taken as shown in figure 2, and it remains that nearly no moments at which the frequency is over 1%. Therefore, the threshold was set as 1% for SST series. Some explanation about the threshold is added in the manuscript.

2.Referee. Once performed the point 1 it is possible that the number of abrupt changes diminishes. In any case I suggest to the authors to make the effort to give an explanation of the patterns in terms of climate systems. Thus for example in figure 1 the changes detected in 1976 and 1982 are related to ENSO area. The change of 1976 is a well documented phenomenon called climate shift. In 1982 one of the most important

C2

ENSO episodes took place.

Authors. The change of 1976 is known as a climate shift in the previous work, and it's an abrupt change "point". The abrupt changes of other periods also have similar background. Some explanations in terms of climate systems are added in section 3.1 of the manuscript as follows:

"It's obvious that the abrupt changes start in 1878 and 1942 mainly occurred in Indian ocean. And the Indian Ocean Dipole(IOD) of this two periods got strong negative phase and strong positive phase respectively(Suryachandra et al, 2002), which could be the trigger of the abrupt changes. The abrupt change start in 1976 is known as a climate shift, and most climate elements were detected to experience abrupt changes. The abrupt changes of 1890-1920 occurred mainly in Pacific ocean, and it is associated with Interdecadal Pacific Oscillation(IPO) index which transits from negative phase to positive phase during this period. The abrupt changes start in end of 2000s mainly occurred in high latitudes, which leads to a significant increase of temperature in the polar."

3.Referee. As a minor question I also suggest to carefully read the paper because there are some important mistakes.

Authors. The authors thank the anonymous referee, and some mistakes are corrected.

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Appendix:

Figure 1. Frequencies of the start moment and end moment based on an ideal numerical experiment.

Figure 2. Frequencies as figure 1, but 10 ideal experiments.

Correction about the manuscript

A new edition of the manuscript is submitted as a supplement, some modification about

C3

the new edition:

1. Some mistakes mentioned by the referees are corrected;
2. Figure 1 is replaced by a new edition;
3. One paragraph about the climate background mentioned by referee #2 is added in section 3.1;
4. Two references are added in the manuscript;
5. Some other mistakes are corrected in the manuscript.

Please also note the supplement to this comment:

<http://www.nonlin-processes-geophys-discuss.net/npg-2016-7/npg-2016-7-AC2-supplement.pdf>

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Interactive comment on Nonlin. Processes Geophys. Discuss., doi:10.5194/npg-2016-7, 2016.

C4

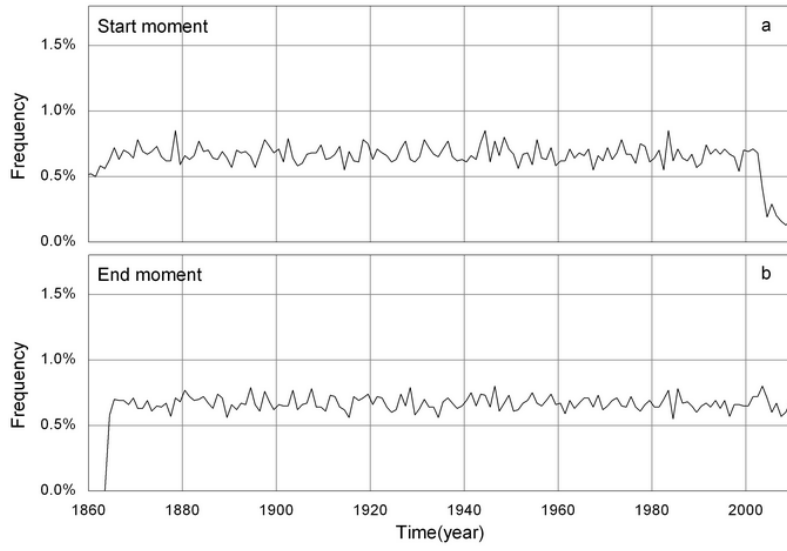


Fig. 1.

C5

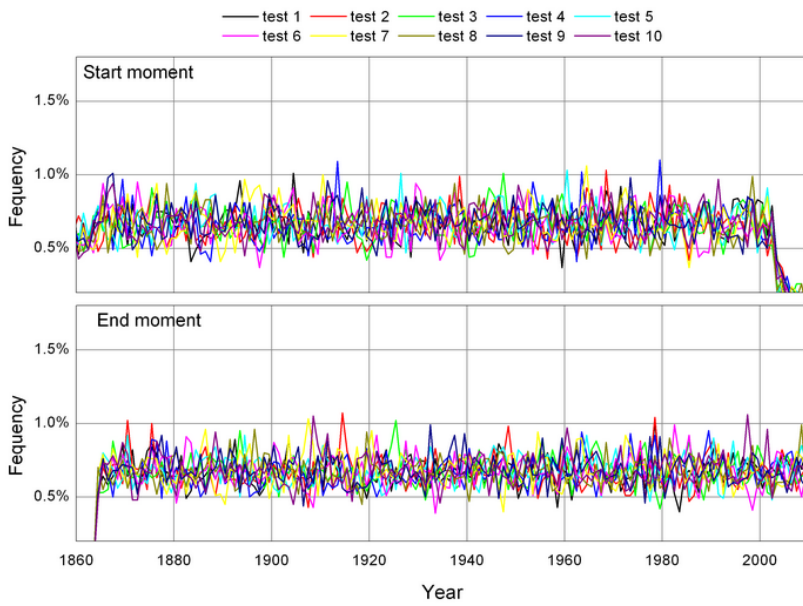


Fig. 2.

C6