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Interactive comment on "A method to predict the uncompleted climate transition process" *by* Pengcheng Yan et al.

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REPLY to RC1

Dear reviewer,

Thanks for the comments, we modify the manuscript according to the comments and reply them one by one as follows. More details are included in the supplement for the plain text can not display the entire reply especially the symbols.

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General comments

"The paper needs major changes to address all issues. The developments in Sub-

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section 2.1 from page 4 to page 7 line 5 already appear in the first part of section 2 of ref."Yan PC, Feng GL, Hou W. A novel method for analyzing the process of abrupt climate change. Nonlinear Processes in Geophysics 2015; 22:249-258, doi: 10.5194/npg-22-249-2015" pages 250-251 and do not introduce any new information. They should be omitted and cited or resumed."

REPLY: In the previous paper of ref."Yan PC, Feng GL, Hou W. A novel method for analyzing the process of abrupt climate change. Nonlinear Processes in Geophysics 2015; 22:249-258, doi: 10.5194/npg-22-249-2015", we introduced the detection method for transition process of climate change in detail. In this manuscript, we develop this method to predict the uncompleted transition process. Thus, the introduction about the method is necessary. Now, we omitted the unnecessary part about the method, and introduce briefly.

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"The method to determine the values of location parameters α and β, or the position of points A and B is not clearly specified."

REPLY: We mark point A and point B in figure 2d, and add two lines in figure 2d to explain how to define parameters α and β. Parameters α and β are defined to introduce xa and xb.

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"The numerical tests of section 2.1 are not fully specified neither its purpose."

REPLY: In section 2.1, we define a new parameter χ to simplify Eq.(7) for now, and the relationship among χ, α, β is shown in figure 3b. we find that the changing of χ is limited even the change of parameter α is 25%. Besides, there is little influence on the detection of parameters if the position of the points(the values of parameters α and β) are indefinite. We add more explanation in the manuscript.

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The results of simulated prediction method of section 2.2 are drawn in figure 5 but not quantified in the text, so the quality of the prediction method can not be appreciated.

REPLY: We add more description in manuscript as follows:

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“For the entire time sequence, there are 500 moments as shown in figure 5a. In figure 5b, only 240 moments are given, and the other moments are unknown. Then, we obtain parameters v and h by regression method. Then, Parameter u is calculated with Eq(8) since parameter k is given. The blue line represent the prediction result. The transition process would be ended in moment 342 with the end state value 2.92. In figure 5c, the end moment and end state are predicted 356 and 2.65 respectively when the time sequence is given 250 moments. In figure 5d, the time sequence is given 260 moments, and the end moment and end state are predicted 359, 2.58 respectively. The ideal experiments predict the end moment and end state of transition process successfully. The results also show that the longer the transition process experience, the more accurate the prediction.”

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The method described in the paper is based on the use of continuous functions: piece-wise linear functions or logistic model; but it is applied to discontinuous functions: see figures 8 and 11. The lines have jumps and the application of the previous equations to discontinuous functions must be justified.

REPLY: We use the continuous function to express the transition process approximately rather than a piecewise function. And, the real climate time sequence is also continuous indeedly. In the manuscript, we rewrite the paragraph in page 4 line 2-8 as follows:

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“Where t represents time, and xt represent the system states, which is obtained by the linear regression method. It is noted that the climate system is continuous even the sampling sequence that makes it is discontinuous. We used a continuous function to express this transition period approximately, and we also created a novel method to detect the transition period(Yan et al, 2015). The continuous evolution of Logistic model is consistent with the transition process(May, 1976), which is shown in figure 1d. The modified logistic model is expressed as follows: ”

The table with the results of analysis of past 10 years in Section 3.2 is missing.

REPLY: Table 2 was missing, and it is added now.

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Specific comments

2.1 The detection method of transition process Page 3, lines 21-22. “. . . the period around point C is expanded to a longer period, or the period around point C is observed on a more short time scale ...” It is not the same. Figure 1b corresponds to the second option: “observe on a more short time scale” or better “observe on shorter time scale”. The idea is that with a more detailed view, the transition process can be observed.

REPLY: We did some modification about the description as follows:

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“If the period around point C is observed on a more short time scale (as shown in figure 1b), a transition period is obtained, and it is a part of the original time sequence. In fact, many abrupt change could be considered to be a transition period with a more detailed view. ”

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In page 6 line 13 and eq. (12), the amplitude of change is denoted by w, but in eq. (13) the notation is changed to ω.

REPLY: This mistake is corrected

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Page 7, line 6 “According to the numerical experiment...”. Figure 3 is not a numerical experiment; part (b) is a contour map of χ for $0 \leq \alpha \leq 1$ and $0 \leq \beta \leq 1$ and part (a) is a section of that contour map along the line $\alpha + \beta = 1$ (probably).

REPLY: This mistake is corrected

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Page 7, line 8. The assertion “the sum of α and β is 1”, does it mean that figure 3(a) is the profile of figure 3(b) along the diagonal $\alpha + \beta = 1$? Please, clarify. See the remark for the caption of Fig. 3. Page 7, lines 13-15. “Let the sum of α and β be 1, then then the change of parameter χ is only related to parameter α . . . (also in figure 3a)”. This is obvious, χ depends on the two parameters (has two degrees of freedom), by imposing a relationship between the two parameters, you reduce the degrees of freedom to one. This sentence does not add any information and should be suppressed.

REPLY: In fact, due to the symmetry of the transition process to the middle point, we assume that point A and point B are symmetrical about the middle point, and the sum of α and β is 1. We rewrite this part in the manuscript.

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Page 7, line 16. “In figure 3c, three ideal experiments were carried out...”. The experiments were not carried out in the figure 3c. Figure 3c describes the parameters of the three experiments. As noted before, the experiments deserve their own subsection.

REPLY: These are mistakes. We change “experiment” to be “situation”.

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The setup of the tests is not clearly described. From the figure 3c, we know the parameters u, v and k, from figure 3c. Other parameters are in table 1. The test setup will be clearer if table 1 would include all parameters for each test. Parameter h0 in table 1 is not defined. Nothing is said about the time span of tests; if the points are randomly perturbed and how. See the previous remark.

REPLY: In figure3c, we test three different situations with different values of parameters u, v and k. When the values of parameter α are different, the values of parameter χ are almost constant. Parameter h0 and h are defined and obtained as follows in manuscript:

“In addition, linear trends of these three ideal models are calculated according to the points and by regression method which are marked as h0 in table 1. The linear trends are also calculated by the values of point A and point B with Eq(5) which are marked as h in table 1.”

Besides, in table 1, the value of parameter χ is not right. We correct the result in this edition.

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2.2 The prediction method of transition process Page 8 line 7, “. . . there is the quartic function relationship between linear trend and amplitude of change.” Eq. (13) reads h=k ω2 χ. This equation is quadratic in the amplitude ω, not quartic.

REPLY: This mistake is corrected

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Page 8, line 18, We are supposing the repetition of events, assuming all events have the same k. We obtain ν and h. Which is the value of α? We are also assuming that α+β=1, so we can calculate χ.

REPLY: This is a mistake. In section 2.1, an explanation is added. Parameter α is set as 0.2, and parameter χ is 0.2164.

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Page 8, line 23, An ideal time sequence is constructed with a logistic model with parameters v=-1, u=2 and k=0.1. But in figure 5, the steady part of the curve is well above -1 in the left part and above 2 in the right part. From that graphics, the limits seem to be v=-1.5, u=2.5.

REPLY: The ideal time sequence is constructed by using the logistic model and random numbers. The random numbers are limited in (0, 1). We correct this mistake in the manuscript.

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3.1 Threshold of stability parameter k

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Page 9, line 15. The origin of the values for the parameter k (green dots) that appear in figure 6a is missing.

REPLY: It is true that some green dots in figure 6s are missing. These missing dots represent the value of parameter k are large. For example, during 1960∼1970, the threshold of k value is about 200-600 as shown in figure 6a, which means these abrupt changes are unstable. Fortunately, most abrupt changes are stable as statistical results in figure 7.

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3.2 Determination of abrupt change and the threshold for initial state ν and linear trend h

Page 11, line 8, “We use the method to analyze...” But the method is not specified.

REPLY: “The method” means the method proposed in section 2.2 in this manuscript. We correct this mistake.

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Page 11, line 10, “Parameters ν and h are obtained . . . abrupt changes (Table 1).” But the title of table 1 is “The parameters for ideal models” and also written in page 7, line 18. Is there another missing table?

REPLY: It should be table 2. Table 2 is added in the manuscript.

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Page 11, line 21. “. . .the abrupt change determined through the percentile threshold method ...”. This method must be described or referenced.

REPLY: The percentile threshold method is a statistical method for studying extreme events. The reference here is added now.

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Page 11, line 23. Along the paper, time series were approximated by piece-wise continuous functions: the system was in a steady state, and from that value changed up or down. But in figure 8 time series are approximated by functions with jumps from the value of the steady states to the beginning of the slope lines that approximate the changes. These profiles are different from those used in figure 5 to simulate the process of recovering the parameters and those of the logistic functions.

REPLY: The continuous functions is used to determine the quantitative relationship among parameters. When calculate the values of parameters, we used the optimal linear regression method in different segments. Thus, these profiles are linear lines which are not like the curve in figure 5.

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Page 13, line 4, “...the parameter h=1.054/a...” The units of h are not clear, what does a mean? Year? The same problem appears in line 9 in the same page.

REPLY: The unit of the PDO index with time(month) is 1, so the linear trend of PDO should be month-1. We correct this mistake.

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Figure 3 Caption. (a) part: it is not stated which diagonal of (b) refers to, $\alpha = \beta$ or $\alpha + \beta = 1$. It, also, would be interesting to mark points 1, 2 and 3 from (b) in the part (a) of figure.

REPLY: The diagonal refers to $\alpha + \beta = 1$. A gray line is added in figure 3(b). Points 1, 2 and 3 represent three different situations, and we mark them with S1, S2 and S3. We also change the description in table 1.

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Technical corrections

Cites should be separated from text by a blank, e.g. p. 2 line 1 ". . . change (Charney ...)" and many more. Page 6 line 4 "Then, we do integration...", I consider better "Then, we integrate..."

REPLY: We correct these mistakes.

Please also note the supplement to this comment:
https://www.nonlin-processes-geophys-discuss.net/npg-2020-2/npg-2020-2-AC1-supplement.pdf

Interactive comment on Nonlin. Processes Geophys. Discuss., https://doi.org/10.5194/npg-2020-2, 2020.