Responses to Reviewer#2

1. These conclusions are based on a thorough analysis of the multi-model PMIP3 past1000 ensemble. The authors first establish the performance of individual models in representing present-day climate variations and base the selection of models on this evaluation. The results could be more robust if the authors included also the CESM single-model ensemble in the analyses of section 4.1 (see below). I am much less convinced about section 4.2, where the authors claim that a roughly 60yr oscillation in some teleconnections to the North Atlantic causes the variations in the EASM-precip relation. I don't find the collection of spectra very convincing and strongly recommend not to derive spectra from heavily-smoothed time series.

Thank you very much for the constructive comments.

1. We include the CESM-LME results in Page 6, Line 31-34, and attach the corresponding figure in the supplement (Fig. S3).

2. The multi-decadal periodicity of PRCs/PCs differs among different models. On one hand, the RPC/PC depends not only on variations of the winds and precipitation but also on their relationship. This makes their spectra more complicated than a simple index, such as a precipitation index. Thus, the different parameterizations relevant to precipitation and winds among PMIP3 models may lead to the diversity of their spectra. On the other hand, the key factor affecting the fluctuation of the PRC/RC may vary even among the same model simulations (i.e., CESM-LME). The correlation between the AMO and EASM-precipitation relationship is relatively low, though it is statistically significant (Fig. 11). This result suggests that other factors except for the AMO may also contribute to the RC fluctuation, while not robust among the ensemble members. Take the PDO for example, we show that the SST variation over the North Pacific is more sensitivity to the initial conditions than that over the North Atlantic (Table S1 and S2), making their phase combinations differ among CESM-LME (Fig. S7). In other words, the connection between the AMO and EASM-precipitation relationship is affected by the PDO in different ways among the CESM-LME, making the spectra of RC/PRCs more complex. We add some discussions on this point (Page 8, Line 1-8) in the revised manuscript. Considering these reasons, we modified the "roughly 60-year periodicity" into the "multi-decadal periodicity" throughout the manuscript.

3. It is possible that heavily-smoothed time series could induce spurious peaks in the spectrum. To avoid this problem, we applied a Monte Carlo simulation to verify the significance of the spectral. Specifically, we generated two random arrays with the same length of the original data, and then calculate the spectrum of their 31-year running correlation. We repeat previous steps 10,000 times and get 10,000 spectra, the fifth (tenth) percentile at each timescale is set as threshold for $\alpha = 0.05$ ($\alpha = 0.1$). As shown in Fig. 10, the running correlation will induce some spurious spectral peaks on the short timescales (i.e., 22-year) but not on the timescale we concerned (i.e., around 60-year). We introduce the Monte Carlo simulation in Page 4, Line 9-14.

2. The connection with the Atlantic Multidecadal Oscillation is also not well established. The correlations shown in Fig.11 show extremely low explained variance, even though they may pass a statistical significance test. In an earlier paper (Shi et al., Clim. Dyn., 2016) the principle author did a much better job in identifying teleconnections influencing precipitation patterns in a particular model. If the AMO-China precip connection is as robust as the authors claim, the multitude of realisations from the CESM ensemble should make it possible to nail down the pathway how and

to which amount the AMO influences the eastern China rainfall in comparison to the EASM.

We add some discussion on the possible mechanisms about the possible mechanisms that AMO affected the EASM-precipitation relationship (Page 7, Line 23-31). However, it is difficult to distinguish the roles of AMO and EASM in precipitation over eastern China, as AMO also affects the EASM via modulating large-scale circulations (Lu et al., 2006; Yang et al., 2017).

The formation of precipitation is not only affected by the moisture but also related to the local thermal condition. When the temperature gets lower, the moist air gets easier to saturate if the moisture is constant. Previous studies have shown that the AMO could influence the temperature over East Asia positively (Lu et al., 2006; Wang et al., 2013). During the cold (warm) phase of the SST anomalies over North Atlantic, the temperature over East Asia tends to be colder (warmer) (Fig. S6). As the EASM strengthens, the moisture transported to monsoon region increases, which is propitious to improve precipitation. Meanwhile, the lower (higher)-than-normal temperature condition over East Asia is helpful (unhelpful) to the saturation of the air and thus promote (hamper) the formation of precipitation, which results in a more (less) robust positive EASM-precipitation relationship.

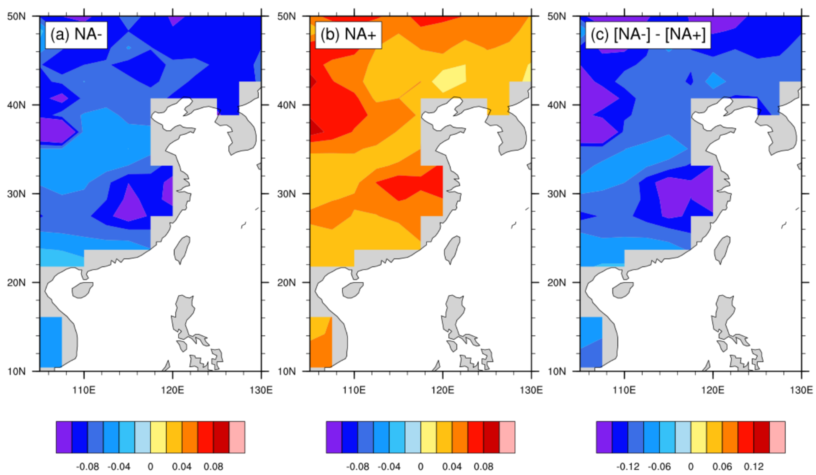

Figure S6. The summer surface temperature anomalies during the (a) negative phase (NA-) and (b) positive phase (NA+) of SSTA over the North Atlantic (30°–70°N, 80°W–0°). (c) The difference in summer surface temperature between the NA- and NA+. The NA+ (NA-) is selected for the time periods that the summer SSTA over North Atlantic exceed its 1.2 (-1.2) standard deviation. Units: °C.

References:

Yang, Q., Ma, Z., Fan, X., Yang, Z. L., Xu, Z., and Wu, P.: Decadal modulation of precipitation patterns over eastern China by sea surface temperature anomalies, J. Climate, 30, 7017-7033, 2017.

Lu, R., Dong, B., and Ding, H.: Impact of the Atlantic Multidecadal Oscillation on the Asian summer monsoon, Geophys. Res. Lett., 33, 2006.

Minor issues:

1. Page1, line 23 have == has Page 2, line18: do you mean “combing” or “combining”?

Corrected. We mean “combining”.

2. Page 2, lines32ff and general: I recommend to reduce (increase) the wording in parenthesis in

order to improve (deteriorate) the clarity of the argument.
We modified the manuscript as you suggested. (Page2, Line 19-21)

3. Page 3, line 5: Peng et al., 2014: for which time period?
During the last millennium (Page 3, Line 6).

4. Line 6: the previous work by Shi et al is important and you should give a brief summary of their findings.
We add a brief summary of Shi et al. (2016b). (Page 3, Line 6-10)

5. Also for the later part: In Shi et al. 2016 it is concluded that only one model is able to adequately reproduce the precipitation patterns over China in the last millennium context. Why is that not so important for the present study?
In Shi et al. (2016a), they mainly focused on the divergent response of annual precipitation/humidity condition between arid Asian inland and Eastern China (monsoonal region), and select the models based on the annual humidity difference between the MCA and LIA in comparison with multi-proxies. In this study, we concentrated on the relationship between summer precipitation and winds over China. We choose models based on their performance in simulating the EASM strength and EASM-precipitation relationship, which is difficult to compare with the proxies. Thus, in Shi et al. (2016a), their model selection was stricter than that in this study. In addition, their result further agreed with one of our main conclusions that the EASM-precipitation relationship is positive and stable on multi-centennial timescale.

6. Line 21: the PMIP3 definition is exactly 850 to 1850 A.D.
Corrected.

7. Page 4, line 2, page 5, line 11: why geological? Geographical, spatial?
Corrected to “spatial”

8. Page 5, line 11, figures 1,4: the “observations” are from a relatively short period (1979- 2000). In the light of the later results on the non-stationarity: How does one know that this period is representative for the 20th century or longer?
We modified the observational EASM and EASM-precipitation relationship calculated from 1948-2000, and the simulated EASM and EASM-precipitation relationship are derived from 1901-2000. (Fig. 1 and 4; Fig S2)

9. Page 6, lines 6ff: The results could be made more robust if the CESM LM Ensemble simulations would be included. For example, in figure 2c one could have another entry for CESM LME including an estimate of the ensemble spread. So you would provide both a multi-model ensemble and a single-model ensemble.
Thanks for your suggestion and we added CESM results in the revised manuscript (Page 6, Line 31-33) and corresponding figure in the supplement (Fig. S3).

10. Page 6, lines 14ff: I don’t find the periodicity so obvious. If one requires 95% significance, only

5 out of 14 PMIP models and 3 out of 9 LME simulations meet the criterion, hardly a very robust feature. Again, the spectra should not be calculated from smoothed data.
First, as you suggested, we applied a Monte Carlo simulation to avoid the possible spurious spectral peaks caused by filtered time series. We acknowledge that in some of these simulations, the spectral peaks are significant at 90% significance level, not robust compared to the 95% significance level. Nevertheless, almost all multi-decadal spectral peaks among these simulations pass the 90% significance test, which possibly indicates that it is a common and robust sign among climate models, thus increasing its credibility to some extent.

11. Line 15, and page 7, line 13: There is only one Shi et al., 2016 in the reference list.
References Shi et al. (2016a) and Shi et al. (2016b) are added. (Page 11, Line 32- Page 12, Line 2)

12. Line 29: I would say there are as significant peaks between 120 and 150 years in several of the individual forcing runs (e.g., 10 b, f,I,n)
As shown in Fig. 10, the CESM control run has a significant 120~150-year periodicity besides the multi-decadal periodicity. It indicates that the similar 120~150-year occurring in some CESM single-forcing runs may also result from the internal variability of the climate system. The lack of the 120~150-year periodicity in the remaining single-forcing runs possibly implicates that this periodicity is sensitive to the initial condition. We add some discussions on this point in the revised manuscript (Page 7, Line 4-7 and Line 17-18).

13. Page 7, line 29: “geological evidence” better: from proxy data
Corrected.