We are very grateful for the constructive comments, suggestion and questions from the reviewer #1. According to these, we have done careful revision to our manuscript. The following text gives our point-by-point replies and explanations (in black) to the issues listed (in blue and italics).

General comments: As described in the manuscript, the factors causing droughts are diverse. Therefore, the idea is very correct to study the causes of each specific drought events, respectively. e.g. the stronger volcanic activity may lead a specific drought, and another may be induced by the weakened monsoon. However, both cannot lead all drought events. The other factors have similar problem. Thus, this article is very important to improve understanding of the formation reasons of droughts in eastern China. Moreover, the comparison of proxy reconstruction and simulation is a potentially practical way to understand the spatial and temporal characteristics of drought events in the past and reveal the internal mechanism of their occurrence. However, the conclusion is too hasty.

Firstly, the proxy data and simulation data all were averaged by a 10yr-running mean. Thus, the drought persistent should be more than 10 years, and the drought periods should be redefined.
Agree. We redefined the droughts periods in our revised manuscript (Please see corrections throughout the revision).

Secondly, the simulations from other models in CMIP5 are available. I suggest you need check more model simulations to verify the conclusion.;
One figure (Figure 10 in the revised manuscript) showing CMIP5' models ability to simulated the variations of precipitation over eastern China were added in the revised manuscript as suggested by Reviewer. We compare model simulation results with the proxy data and between the different scenario experiments in Section 4.3 in the revised paper and describe which simulations in CMIP5 are choiced in Section 2 (see following).

"4.3 Comparison with multi model experiments
To further investigate weather the characteristics of severe persistent droughts over eastern China revealed by CCSM2.0 are robust across multiple model experiments, we also present results for multi-model comparisons using 5 simulations from the collection of last millennium experiments in the CMIP5 archive. Figure 10 clearly displays that there is no common drought signal in the rainy season precipitation time series over eastern China for all simulations. There is no individual simulation in the CMIP5 archive can produce all 10 persistent droughts identified by the proxy data and the 6 well-captured droughts by CCSM2.0. However, compared to CCSM2.0, the precipitation series agree slightly better with the reconstruction during the drought periods around 1520s and 1920s. The differences of architectures in the models and the differences of forcing and initial conditions sets can possible result in differences between the simulations (Bothe et al., 2013). Considering the full ensembles, no common forced signal can be found. Thus we do not further discuss it in depth";

"Monthly mean precipitation flux data from the Coupled Model Intercomparison Project – phase 5 (CMIP5) past1000 and historical experiments are also used here. The past1000 simulations, available at http://cmip-pcmdi.llnl.gov/index.html, were performed with multi models. From each GCM, only one run is used and only if it is available both for the last millennium and the historical experiments, and if it completely covers the 1000–2000 period. We also exclude the simulation with MIROC-ESM since it shows a problematic long-term drift (Bothe et al. 2013), and the CSIRO data as they consider solar forcings as presented by Steinhilber et al (2009) which different from other models. Thus, GCMs from the CMIP5 used in

our study include bcc-csm1-1 (BCC), CCSM4, GISS-R24 (GISS), MPI-ESM-P (MPI), and IPSL-CM5ALR (IPSL)"

Thirdly, uncertainty of proxy data reconstruction should be considered? In spite of the historical documents that are more accurate than the current simulation, you should mention the uncertainty. e.g. the Dry-wet indices have some missing values, especially in the early years. Thus, this manuscript needs a minor revision before publish.

Agree. In the revision, we discussed the uncertainty of proxy data reconstruction in Section 4.1 and Section 5. We additionally provided crucial references to point out the possibility that the proxy data may underestimates the decreasing trends during the middle 19th century and middle 20th century due to such uncertainties (see following).

"Although significant decreases in rainy season precipitation over eastern China during the periods of 1830-1853 and 1958-1976 are observed in the dataset of DWI consisting of 48 regions (Zheng et al., 2006), the climate in these two periods was still considered to be at wet or normal conditions. It seems it is possible that the model overestimates the decreasing trends in rainy season precipitation in the period of the 1830s and 1960s. But we also note drought conditions during the middle 20th century could observed in the dataset of DWI consisting of 120 regions (Zhang et al., 2003). Significant differences in precipitation during 1960s between these two proxy datasets indicate that too much missing records in the proxy data of Zheng et al. (2003) likely will have a significant effect on a hydrologic assessment. Furthermore, the D/W index has been criticized. Ge et al. (2007) point the D/W index is a qualitative rather than a quantitative reconstruction of precipitation and not as useful as other proxy data in detailing truly large-scale precipitation variations and model-data comparisons. Thus, having such a large uncertainty in proxy data reconstruction from historical documents, it is also possible that the proxy data underestimates the decreasing trends in rainy season precipitation during these two periods."

Specific Comments:

1. P6346, line 5. 'many aspects' is not precise. Here, the results just indicate the model can depict several persistent drought events in decadal scale. The averaged index in the study region is only an aspect. In fact, for all I know, many climate models in CMIP5 cannot accurately capture the spatial characteristics of precipitation in China.

Agree. The sentence is corrected. The sentence was changed to "Results show that the model was able to roughly simulate most of the severe persistent droughts over eastern China during the last millennium such as those occurred during the periods of 1123-1152, 1197-1223, 1353-1363, 1428-1449, 1479-1513, and 1632-1645". P2, L5-9.

2. P6346, line 21-23. Another possibility may be the proxy data reconstruction underestimates the decreasing trends.

Agree. The sentence was changed to "Our analyses also indicate that large volcanic eruptions play a role as an amplifier in the drought of 1631-1648 and caused the droughts of 1830-1853 and 1958-1976 identified by the model". P2L20-22. The similar problems were corrected accordingly in section4.1 and section 5 (See reply to the third general comment of Reviewer #1 above).

3. P6347, line 2. 'great recurring' should be changed with 'main'. Since the droughts may have no stationary periodicities.

Corrected.P3L3

4. P6347, line 2-5. There is a little problem in logic expression. The sentence should is that 'Since the frequency and intensity of droughts has increased globally in recent years and its significant impacts on economy, society, and environment (Easterling et al., 2000; Changnon et al., 2001;

IPCC, 2002), droughts have been received increasing attention.'
Corrected.P3L4-7

5. P6347, line 4. It is better to cite the new IPCC report.
Agree. We cite a new IPCC report.
Reference "IPCC: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp, 2012." was cited.

6. P6347, line 6-10. The death toll about the 1960s drought is incorrect. One million deaths of two 2-year major droughts in 1928-1929 and 1965-1966 include China and India (Shen et al., 2007). The information at the website is that two years of severe droughts in 1941-1942 in China leave 3 million dead by starvation. Please check it.
Corrected. The sentence was changed to "For example, the most recent drought of this type, which occurred during the 1960s, caused more than 1 million deaths in China and Indian (Shen et al., 2007)." P3L9-11.

7.P6347, line 13. Some references should be added to support the considerable effort.
Added. "Wang et al. 2000; Zhang et al. 2005; Zheng et al. 2006; Shen et al. 2007; Qian et al. 2012; Yang et al. 2012; Barriopedro et al. 2012" have been provided in the Reference List. P3L14-16.

8. P6348, line 15. A sentence should be added to summarize the status of these studies, for example, A great deal of literature works has been carried out in drought events, but the possible mechanism remains unclear because of the complex climate
system in eastern China.
Added as the review's suggestion.P5L9-11.

9. P6349. Line 14. The May-September should be rainy season not summer.
Corrected (Please see corrections throughout the revision).

10. P6350, line 15. There are many indices to depict the EASM variability. Please illustrate the reason that the index (Sun et al. 2000) was chosen in this study in detail. Moreover, this index is not first developed in this paper, and you just use it. Thus, the title '3 defining : : :' is not rigorous.
Agree. We give the reason in section3, that is "The choice of monsoon index here is somewhat subjective because there are many types of EASM indices. The index provides a direct measure of large-scale thermal difference between the land and sea for the EASM variability and thus it is used as an EASM index in the present study". The title is changed to "The index of land-sea thermal difference".

11. P6351, line 4. How much is the sample window? I suggest that an odd number (9 or 11) of datum points as the sample window for the central running mean.
The sample window is 10 yr. We give reasons in section 4.1. (see following)

"Due to that 10-yr running average was involved in developing regional DWI for eastern China over last 1000 yr, high frequency variability in the regional DWI time series was removed (Zheng et al., 2006). Therefore, this data set with 10 yr time resolution. For matching the time resolution of the DWI index series from the proxy data of Zheng et al. (2006), the DWI series from the

proxy data of Zhang et al. (2003) and modeled data have all been subjected to a 10yr running mean to remove the effects of interannual variability and to retain variability on timescales of just under a decade and longer. After the smoothing, the modeled precipitation time series are standardized."

12. P6351, line 25. Please explain how to define the threshold. I guess that the value '-0.43' is equal to the 1.28 times the standard deviation. If I am right, the order of these sentences is not appropriate. The principle should be firstly introduced, and then the threshold is calculated according to the principle.

No, it is not equal to the 1.28 times the standard deviation. In our revised manuscript, for matching the DWI index series, the modeled precipitation has been subjected to a 10yr running mean first, and then standardized. P10L13-14 .The sentence was changed to "To identify these events, We selected the periods of negative values of 10 yr running mean of precipitation for eastern China exceed 1.32 times the standard deviation for at least 5 consecutive years, meaning that the probability of drought occurrence is 10% (Solomon et al., 2007a)", and one reference was added to support this approach of defining severe decadal drought.

"Meehl, G. and Hu, A.: Mechanisms of drought in present and future climate. In: Program for the 33rd Annual Climate Diagnostics & Prediction Workshop/CLIVAR Drought Workshop, Lincoln, 3pp, 2008."

13. P6353, line 8-10. The result of comparison of proxy and model is not good. The drought centers and the periods are both different. Thus, it is difficult to get a conclusion 'in terms of drought intensity, duration, and spatial coverage, these six droughts over eastern China revealed by our model are consistent with the results of proxy data'. I suggest you compare them on a longer time scale.

Agree. We compare them on a longer time scale in fig.2 follow the droughts periods in our revised manuscript redefined as suggested by the Reviewer. We also analysis the pattern correlations between the proxy data and model simulations for the two events as suggested by Reviewer #2, discuss the possible reasons caused simulated errors of the drought centers and give a more convinced conclusion about the model's ability to produce these droughts (see following).

"The pattern correlations over eastern China between changes in modeled precipitation anomalies and DWI (Zhang et al., 2003) are -0.59 and -0.83 during theses two droughts, respectively. Note, for our purposes herein, the modeled precipitation is regridded from their native resolution to an even 0.5^0 x 0.5^0 grid. It seems CCSM2.0 overestimates the drought conditions in the regions south to 35 ^{o}N, whereas it underestimates in the regions north to 35 ^{o}N during the last two droughts. Our previous work (Shen et al., 2009) have point out it indicates CCSM2.0's performance in simulating the effect of the Tibetan Plateau on precipitation needs to be improved. In spite of these errors, the model simulates the general features of these six severe persistent droughts in terms of drought intensity and duration and the droughts in the model temporally synchronous with those in the paleoclimate record, implying that the model capable of producing these droughts that are characteristic of the paleoclimate record."

14. P6354, line 4-5. From Figure 4, the first three droughts (1133-1140, 1204-1210 and 1356-1360) occurred in the periods following weaker indices (ILSTD), however, the other three droughts are not the same case. Thus, the conclusion that the weak summer monsoon during these droughts may be driven by the changes of land–sea thermal contrast is too rough. If you want to get this conclusion, you need check all weaker index periods and explain why the

droughts do not occur in some weakened monsoon periods.

Agree. We further calculate the correlation between the decadal variations of rainy season precipitation over eastern China and the land-sea thermal contrast during the last millennium as suggested by Reviewer #2, and find a significantly correlations between these two series ($r = 0.21$, $p < 0.01$), explain why the droughts do not occur in some weakened monsoon periods, and give a more convinced conclusion about the relationships between ILSTD and monsoon variations (see following).

"The decadal variations of rainy season precipitation over eastern China correlates significantly with the land-sea thermal contrast during the last millennium ($r = 0.21$, $p < 0.01$), and six droughts that occurred in the periods following weak index corresponding to the weak EASM, suggesting that the changes of land-sea thermal contrast may contribute to the weak summer monsoon during periods of these droughts. Note that not each weaker index periods results in a severe persistent drought event in the model. The land-sea thermal contrast is, therefore, not the only mechanism driving persistent precipitation anomalies over eastern China in the CCSM2.0 model, and the climatological mechanism for severe decadal drought events is more complex than those we discuss here."

15. P6455, line 1-3. From Figure 5 and 6, the similar quasi-periodicities were found by the spectral analysis. It is better to try to explain how to the dynamics mechanism about the solar activity and the internal variability of the climate system in detain.

Agree. We explain how to the dynamics mechanism about the solar activity and the internal variability of the climate system in Section 4.2.1. Considering this and the 17th suggestion of Reviewer #1 and the first and 5th comments of Reviewer #2, we add a Section (Section 4.2.1 in revised manuscript) and one figure (fig.3 in the revised manuscript) to discuss the possible relationships between DWI and climate forcings time series (solar variability, volcanic eruption, and ENSO/PDO) during the last 1000 years. In Section 4.2.1, we firstly explain the dynamics mechanism about the solar activity, volcanic eruption and the internal variability of the climate system in detail, and then we assess the possibility of the linkage between DWI and climate forcings during the last 1000 years(see following) .

"The internal dynamics of climate modes in the oceans like PDO and the external forcing of effective solar radiation and volcanic eruptions would contribute to the thermal changes which corresponding to the weak EASM, and， hence, cause drought over eastern China. Theoretically, since oceanic and terrestrial heat capacities are different, when solar activity weakens, the temperature of land decreases quickly which caused the thermal contrast between eastern Asia and around ocean weakens. The EASM is weakened, resulting in less precipitation and drought condition over eastern China (Tan et al., 2008). Our previous study (Peng et al., 2009b) suggests that the mechanisms of volcanic forcing involved in producing droughts share some common elements with various solar processes, could be attributed to a weakening of summer monsoon caused by the thermal contrast weakens and a decrease of moisture vapor over tropical oceans. The mechanism for PDO driving droughts over eastern China is probably as follows: during the positive PDO phase, the mid–lower tropospheric mean air temperature over the tropical western Pacific Ocean is anomalously warm, whereas that over the mid–high latitude land is anomalously cold (Cheng and Zhou et al., 2014). This difference indicates a weakened land–sea thermal contrast, which favors weakening of the EASM. Using the data network of DWI over eastern China during last 500 years (Zhang et al., 2003), some previous studies investigated the relationships of precipitation variation over eastern China with such climate forcing factors. The occurrence of a quasi-centennial oscillation in precipitation over eastern China might have been associated with the solar forcing fluctuation on the quasi-centennial time scale (Zhu and Wang 2001). Shen et al. (2007, 2008) suggested that large volcanic eruption could trigger exceptional

droughts over eastern China and found a significant correlation between volcanic eruption events and droughts over eastern China during last 500 years. The data network of DWI over eastern China during last 530 years have also been successfully used to reconstruct the annual PDO index, indicating that PDO has strong impacts on rainy season precipitation over eastern China (Shen et al., 2006).

To assess the possible linkage between DWI of Zheng et al. (2006) and SSTs in the Pacific Ocean during the last millennium, we examine a 700 yr tree ring-based high resolution reconstruction of Niño3.4 SSTs (Li, et al., 2013) and a 1000 yr tree ring-based reconstruction of the PDO (MacDonald and Case, 2005). As shown by Fig.3, we do not find sufficient justification for calling upon ENSO as the causative forcing that brought about the severe persistent droughts over eastern China. Take these well-captured droughts for example, the proxy ENSO reconstructions suggest El Niño-like mean state were sustained through the droughts of 1354-1365 and 1479-1513, and La-Niña-like mean state were sustained through the droughts of 1428-1449 and 1631-1645. The PDO was generally neutral or more La-Niña-like during each of severe persistent drought interval except during the drought of 1482-1513. This result is also found in whole monsoon Asia. By comparing a series of proxy records that reflect changes in El Niño frequency or the mean state of ENSO in the tropical Pacific, Sinha et al. (2010) also found there is no conclusive evidence to suggest that the megadroughts in monsoon Asia were associated with anomalous sea surface temperature anomalies that were solely the result of ENSO-like variability in the tropical Pacific. We also did not find the dry/wet conditions over eastern China in proxy data strongly response to the solar activity during the last millennium. The variations of the DWI series and solar forcing series (Vieria, et al., 2011), after 10 yr and 30 yr smoothing, are not significantly correlated with each other, r = 0.04 and 0.06, respectively. A direct comparison between DWI and the volcanic forcing time series (Gao et al., 2008) can also be made in Fig.3, which shows that dry conditions or significant decreases in precipitation over eastern China occurred in active periods of volcanic eruption. However, the correlation coefficient is -0.04 between these two series. These results provide evidence that hydroclimate variability in eastern China is not solely a response to only one climate forcing changes."

16. P6357, line 23-27. I suggest this conclusion should indicate which drought was caused by the reduced monsoon, since a single factor can not explain all drought events.

Agree. The sentence was changed to "Our analysis suggests that the case for repeated occurrences of severe persistent droughts identified both in proxy and modeled data is caused by EASM weakens, and supports the suggestion that the land-sea thermal contrast changes may be attribute to the reduced monsoon in eastern Asia during these periods."

17. P6358, line 13. There is a high-resolution ENSO developed by Li et al. (2013), which can be used to assess the relationship between the drought and ENSO.

Agree. We examine this 700 yr tree ring-based high resolution reconstruction of Niño3.4 SSTs to assess the relationship between the droughts identified in DWI series and ENSO in section4.1 (See reply to the 15th specific comment of Reviewer #1 above).

18. Please calculate the correlation coefficient and the effective number of degrees of freedom to assess the significance of the correlation in Fig. 1.

The correlation between the simulation and reconstruction by Zheng et al. (2006) is significantly ($r=0.17$, $P<0.01$). (See reply to the similar comment of Reviewer #2).

19. Please indicate the six well-captured severe droughts from the model simulation in Figures.4, 5 and 7.

They were indicated in these three figures in our revised manuscript.

20. What's the 10yr smoothed response in Fig.8?

It is showed in the caption of Fig.9 in the revised manuscript. That is "Annual anomalies (gray curve) are shown along with smoothed versions using a 10yr running average (black curve)."

Reference: Li, J., Xie, S.-P., Cook, E.R., Morales, M.S., Christie, D.A., Johnson, N.C., Chen, F., D'Arrigo, R., Fowler, A.M., Gou, X., Fang, K., 2013. El Nino modulations over the past seven centuries. Nature Clim. Change, 3(9), 822-826.

Added in the reference list.

Shen, C., Wang, W.C., Hao, Z., Gong, W., 2007. Exceptional drought events over eastern China during the last five centuries. Climatic Change, 85(3), 453-471.

Added in the reference list.