Point-to-Point responses to the referee's comments:

Referee #2:

Northern China is one of the most important cradles of Chinese civilizations, which makes it an ideal region to study climate change and culture evolution. While high resolution regional rainfall records during the Holocene were reconstructed in the recent years, temperature records longer than 2000 years are scarce. This study reconstructed the temperature variability during the past 4000 years in northern China using fossil chironomid assemblages in an AMS 14C-dated sediment core from Gonghai Lake. The chronology of the record is robust, and the interpretation of the chironomid assemblages is convincing. This could deep our understanding of the Holocene climate change in this crucial region. My general comments are as follows: The authors compared the chironomid-based temperature record with pollen-based precipitation re- construction from the same core, and suggested the temperature and rainfall variations in northern China were out –of – phase during 650-900 AD and 1650 AD to present. Then, they suggested the recent decreasing rainfall and increasing temperature pattern in northern China may be due to natural variability. I am not fully convinced. As I see from Figure 6, the temperature and rainfall records are well consistent with each other before 1650 AD, if different resolutions are considered. During 650-900 AD, both temperature and rainfall shown similar pattern, like a letter "M". Although the temperature didn't decrease as much as the rainfall did, this could be due to the uncertainties of the record. Multiple factors could cause the inconsistence between the temperature and rainfall variations during the last 450 years, such as the uncertainties of both reconstructions, possible influence of human activities to pollen and chironomid during the last 450 years. For example, many temperature reconstructions show gradually warming trend from 1650 AD to present, like the records cited in Fig. 5, which is different from this reconstruction. The temperature maintained in a high level during the last 300 years in this record. Moreover, it shows a slight decreasing trend in the last 50 years, which is not true. In addition, Tan et al. (2011, CP) compared the tree ring and stalagmite reconstructed temperature records with synthesized rainfall record in northern China, and suggested a warm-humid/cool-dry pattern on centennial timescale over the last 1800 years. I think the authors should discuss the difference between the temperature reconstruction of this study and other studies in the last 300 years, or just leave it an open question.

Response: Many thanks. We have carefully considered your helpful comments and constructive suggestions, and have revised the manuscript accordingly (P.19-20, L.439-445).

We agree that the temperature and rainfall variations in northern China during 650-900 AD were generally consistent. The climate change pattern in the Gonghai Lake region would be the warm and humid/cool and dry pattern both on millennial- and centennial- scales, which is consistent with a previous synthesis study (*Tan et al., 2011*). The temperature reconstruction of this study in fact shows a broad consistency with other studies during the last 300 years, such as the rapid temperature increase at the end of LIA (see grey bar in Fig. 6). However, it might be difficult to discuss the temperature fluctuations in a more detailed way using a 60 a-resolution record. In addition, the weakening of the Asian summer monsoon suggested by the pollen-based precipitation reconstruction in Gonghai Lake during the last 300 years might be due to various factors, such as the possible impact of human activities. Therefore, more high-quality precipitation records are needed to further validate such a warm and dry configuration in this period.

Tan, L.C., Cai, Y.J., An, Z.S., Yi, L., Zhang, H.W., and Qin, S.J.: Climate patterns in north central China during the last 1800 yr and their possible driving force, Climate of the Past, 7(3), 685, 2011.

The other suggestion is that the authors should emphasize the differences of this work and the previous one (Wang et al., 2016) in the Introduction. In the previous study, the same authors used chironomid assemblages from this core to reconstruct rainfall variations. I understand they are different assemblages, but general readers will benefit from a clearer explanation. The authors mentioned it, but not enough.

Response: Many thanks for this suggestion. We have highlighted the major content of this study in the **Introduction,** which will help general readers to obtain a clearer picture. The biggest difference between these two studies is that the previous study indicates that the chironomid assemblages mainly respond to precipitation variability through water depth fluctuations, whereas this study focuses on using certain stenothermic taxa to reconstruct past temperature changes. The temperature record in this study has more samples and a higher resolution, and only the temperature indicator species were used. Please refer to the revised **Introduction** for more details (P.4-5, L.89-93, 100-102).

I also have some special comments:

1. If the inconsistence of temperature and rainfall variations are plausible, conclusion 3 in the abstract should be modified. Rainfall changes could also had influenced the human society in northern China.

Response: The conclusion 3 in the abstract is based on the results of Pearson correlation analysis and Granger causality analysis of cold-preference taxa, reconstructed precipitation and the incidence of war. We agree that rainfall changes could also have influenced the human society in northern China as a whole. However, the relationship between climate change and societal implications in our study is limited to Shanxi Province. On such a regional scale, further work is needed to explore the influence of precipitation changes on human society.

2. Line 46: Stalagmite $d^{18}O$ record from Dongge cave is not a typical EASM rainfall record, so Dykoski et al. (2005) should be removed from the reference list. The authors can replace it with Hu et al. (2008, EPSL) or Cai et al., (2010, EPSL).

Response: Thanks. Dykoski et al. (2005) has been deleted, and Hu et al. (2008) and Cai et al. (2010) have been added in the revised manuscript (P.3, L.47).

Cai, Y.J., Tan, L.C., Cheng, H., An, Z.S., Edwards, R.L., Kelly, J.M., Kong, X.G., and Wang, X.F.: The variation of summer monsoon precipitation in central China since the last deglaciation, Earth Planet Sci. Lett., 29, 121-131, 2010.

Hu, C.Y., Henderson, G.M., Huang, J.H., Xie, S.C., Sun, Y., and R. Johnson, K.: Quantification of Holocene Asian monsoon rainfall from spatially separated cave records, Earth Planet Sci. Lett., 266(3), 221-232, 2008.

3. Line 92-94: Tan et al. (2011, Holocene) compared the climate changes and war frequencies in northern China during the last 1860 year, and detailed discussed the impacts of regional climate changes on social evolution. This paper should be cited.

Response: Tan et al. (2011) has been cited in the revised manuscript (P.5, L.100). Especially, it gave us more thinking about the impacts of precipitation changes on social evolution on different spatial scales.

Tan, L.C, Cai, Y.J., An, Z.S., Edwards, R.L., Cheng, H., Shen, C.C., and Zhang, H.W.: Centennial-to decadal-scale monsoon precipitation variability in the semi-humid region, northern China during the last 1860 years: Records from stalagmites in Huangye Cave, Holocene, 21(2), 287-296, 2011.

4. Line 142-146: did you exclude the winter temperature in the reconstruction of TANN?

Response: We did not exclude winter temperature in the reconstruction of TANN. We just did not consider the winter temperature variable in the RDA (Fig. 3b), given the fact that the lake surface freezes in winter (see below photo taken in Jan 2009) which will definitely disrupt the good relationship between water temperature and air temperature (P.8, L161-164). Furthermore, the winter season is not the growing season for midges (*Armitage et al., 1995)*.

Armitage, P.D., Cranston, P.S., and Pinder, L.C.V. (Eds): The Chironomidae. Biology and ecology of non-biting midges,. Chapman and Hall, London, 1995.

5. Line 186-188: seems inconsistent with line 143-146.

Response: We have revised the previous statement (P.8, L161-164). Please refer to the response to the above comment.

6. Better to combine section 5.3 with 6.2 and section 5.4 with 6.4.

Response: Many thanks for this suggestion. It is a hard decision to separate them. To combine section 5.3 with 6.2 and section 5.4 with 6.4 could simplify the paper and make it easier to read. However, our main concern is that sections 5.3 and 5.4 are the results of the study which are objective, and sections 6.2 and 6.4 are the corresponding discussion. If they are combined, readers might find it difficult to assess the results independently.

7. It's better to use bars to indicate different periods in figure 5 and figure 6. It's hard to compare

in the present version.

Response: The fact that the bars in Fig. 5 and Fig. 6 are difficult to distinguish may be due to their very light color (and the low resolution of the image). We have darkened the color of the bars (please refer to Fig. 5 and Fig. 6 in the revised manuscript).

8. Line 382: 1150-1350 cal yr BP should be MWP, and 650-950 cal yr BP should be STWP.

Response: 1150-1350 cal yr BP, which equals 600-800 AD, should be STWP. 650-950 cal yr BP, which equals 1000-1300 AD, should be MWP. We did not use "AD" here because many other records for comparison used "cal yr BP".

9. Line 453: as I see from figure 6, the rainfall also decreased during 760-230 BC and 260-600 AD.

Response: Many thanks for this comment. We agree that the rainfall also decreased during 760-230 BC (2180-2710 cal yr BP) and 260-600 AD (1350-1690 cal yr BP). The previous statement is not precise and we have corrected it as "The incidence of war was especially high during 900-1050 AD (900-1050 cal yr BP) and 1300-1650 AD (300-650 cal yr BP) when both temperature and precipitation were lower; it was higher at these times than during the periods of 760-230 BC (2180-2710 cal yr BP) and 260-600 AD (1350-1690 cal yr BP) when the decrease in temperature was more severe than that of precipitation" (P.21, L.477-478).