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

Referee #1:

Principal Strengths: This is a very well-written paper, including an especially interesting analysis of the correspondence between a chironomid record and Chinese written history.

Principal Weaknesses: For unknown reasons the authors have relied on a rather subjective indicator (% of cold water taxa) for the climate reconstruction, rather than more statistically rigorous reconstruction methods (e.g., weighted averaging). As a consequence, the conclusions are not especially convincing and are open to criticism. I recommend that the analysis be repeated using these more robust techniques.

Response: Many thanks. We have carefully considered these constructive suggestions. Statistically rigorous reconstruction methods are undoubtedly efficient techniques for reconstructing temperature change. We have tried to reconstruct the temperature change using a high quality modern calibration set. However, currently there is no suitable training set for chironomid-based temperature reconstruction in northern China. The paleoenvironmental application of chironomid analysis is relatively recent in China, and only one chironomid-based modern calibration set for temperature reconstruction was obtained from the southeastern Tibetan Plateau (*E.L. Zhang et al., 2017a and 2017b*). Our chironomid record is from northern China and consists of many different species from the Tibetan Plateau calibration set. The only training set near Gonghai Lake indicates that the chironomid assemblages in this region mainly respond to precipitation variability through changes in water depth (*H. P. Wang et al., 2016*). Fortunately, as we showed in the manuscript, there are several temperature indicator species in our fossil midge record. Furthermore, modern process research using the calibration set near Gonghai Lake suggested that all these indicator-species have significant temperature implications. The indicator-species approach, as one of the basic approaches to reconstructing past climate from paleoecological data, is regarded as the oldest and most commonly used method (*Birks et al., 2010*). The biggest strength of this approach is simplicity and unambiguity. Therefore, we selected it to assess the past temperature changes. In addition, the consistency between our reconstruction and documentary and stalagmite-based reconstructions provides further validation.

Birks, H.J.B., Heiri, O., Seppä, H., and Bjune, A.E.: Strengths and Weaknesses of Quantitative Climate

Reconstructions Based on Late-Quaternary Biological Proxies, Open Ecology Journal, 3, 68-110, 2010.

Zhang, E.L., Chang, J., Cao, Y.M., Tang, H.Q., Langdon, P., Shulmeister, J., Wang, R., Yang, X.D., and Shen, J.: A chironomid-based mean July temperature inference model from the south-east margin of the Tibetan Plateau, China, Clim. Past, 13, 185-199, 2017a.

Zhang, E.L., Chang, J., Cao, Y.M., Su, W.W., Shulmeister, J., Tang, H.Q., Langdon, P., Yang, X.D., and Shen, J.: Holocene high-resolution quantitative summer temperature reconstruction based on subfossil chironomids from the southeast margin of the Qinghai-Tibetan Plateau, Quat. Sci. Rev., 165, 1-12, 2017b.

Wang, H.P., Brooks, S.J., Chen, J.H., Hu, Y., Wang, Z.L., Liu, J.B., Xu, Q.H., and Chen, F.H.: Response of chironomid assemblages to East Asian summer monsoon precipitation variability in northern China since the last deglaciation, J. Quat. Sci., 31(8), 967-982, 2016.

Page 7: The statement that most chironomid taxa "barely survive in winter" is untrue. Many taxa thrive, and grow most rapidly in winter.

Response: Many thanks for this kind reminder. The statement "barely survive in winter" has been deleted (P.8, L.161).

Page 9: The statement that temperature plays "the dominant role in controlling the abundance of chironomid taxa in freshwater" is an overstatement. The dominant environmental control depends very much on circumstance. For example, salinity/osmolarity is more important than temperature in saline lake systems.

Response: We agree that temperature is one of the dominant environmental variables. The statement that "the dominant role in controlling the abundance of chironomid taxa in freshwater" has been revised as "a key role in controlling the abundance of chironomid taxa in freshwater" (P.9, L.190).

Page 12: I see no basis for the statement, "It is evident that the cold-preference taxa were more sensitive to temperature fluctuations and provide more detailed information about temperature variations than warm-preference taxa". The reader is left with no objective evidence to support this statement. It appears to be wholly based on the authors' bias and probably wishful thinking. It would be preferable to include plots for both warm-preference and cold-preference taxa to facilitate the reader's independent assessment. It also raises another issue – how objectively have taxa been assigned to these categories?

Response: We agree with the referee, and the previous statement has thus been revised (P.12-13, L.269-274). For comparison and assessment, the abundances of warm-preference and cold-preference taxa were both shown in Fig. 4. Both groups of taxa indicate an overall cooling trend since 4000 cal yr BP. However, the abundance of warm-preference taxa was much less than the cold-preference taxa and the former were even often absent during the past 2700 years (Fig. 4). To avoid the potential limitations of such presence or absence data, the changes in abundance of cold-preference taxa (which provide more detailed information about temperature variations on a centennial timescale) were primarily used to investigate temperature changes.

To assign objectively the typical taxa to the correct categories, several criteria were used to select indicator species before analyzing the chironomid assemblages in Gonghai Lake. Please see section 5.1 (P.9, L.201-203) for more details.

P. 14: The statement, "This result has rarely been observed in the previous literature, although it has been noted that chironomids often respond significantly to mean July or summer temperature", reflects the authors' strong bias. Since only a handful of climate variables, and no chemical variables (or other physical variables) were included in the analysis, the authors have forced the RDA to select one variable among a series of several very highly correlated variables. This is not an unbiased approach.

Response: Relevant physical, chemical and climatic variables were all included in the investigation of the relationships between chironomid assemblages and environmental parameters in the Gonghai Lake region (*H.P. Wang et al., 2016*), which we should have introduced more clearly. Please see the revision in section 6.1 (P.14, L.309-311).

It was suggested that the chironomid taxa mainly responded to changes in precipitation (*H.P. Wang et al., 2016*). However, the existence of certain typical stenothermic taxa provides a high potential for extracting a temperature signal. To further verify whether the stenothermic taxa (based on the published literature) also have a thermal significance in the Gonghai Lake region, the temperature variables (TANN, summer Tem, June Tem, July Tem, and August Tem) were used as the only variables to constrain the changes in the abundance of the taxa in the calibration set in the present study (please see P.14, L.311-318, and also refer to the response to the previous comment).

P. 15: The authors' proclamation that the temperature variability "is clearly revealed by changes in the abundance of the cold-preference chironomid taxa" also reflects bias. The reader is supplied with no objective means for assessing that statement's validity

also on p. 15: Similarly, the statement that cold preference taxa "responded rapidly and sensitively to even minor temperature fluctuations" cannot be objectively supported. To conclude this would require a highly accurate, highly precise, and independent temperature record. To conclude this on the basis of the chironomid-inferred climate record is clearly circular reasoning.

Response: Previous statements are not precise indeed and have been revised. Temperature variability in the Gonghai Lake region during the past 4000 years is revealed by changes in the abundance of the warm-preference and cold-preference chironomid taxa (Fig. 4). However, the variations in the abundance of the cold-preference taxa were primarily used to investigate the temperature changes (please refer to the response to the previous comments). An explanation for the more resolved temperature signal carried by the cold-preference taxa may be that they were easily able to become dominant in Gonghai Lake and respond quickly to temperature fluctuations due to the lake's relatively high-elevation (1860 m a.s.l.) and the decreasing trend of late Holocene temperature. Please refer to section 6.2 for more details (P.15-16, L.341-347).

Further along on p. 15: I have long been highly skeptical of the use of sediment organic content as any measure of lake productivity. The most organic sediments (95%) occur in bog-enclosed dystrophic systems. In contrast, the small hypereutrophic lakes of temperate grasslands have sediments with much lower (<50%) organic matter content. I strongly suspect that much of the organic matter accumulating in small, forest lakes is actually derived from the surrounding forest and has little or no correspondence with lake productivity.

Response: We agree with the referee's comment that the sediment organic content should be carefully considered as a measure of lake productivity. Gonghai Lake, an alpine lake, is situated on a small plateau in the northern part of the Lüliang Mountains. The C/N ratios of lake sediments,

which is an indicator of the organic matter source in lake sediments (*Meyers and Ishiwatari, 1993*), show a gradually decreasing trend from 12 to 9.5 during the past 4000 years (*S.Q. Chen et al., under review*), suggesting that the authigenic fraction of the organic matter was dominant. Thus, it is reasonable to infer that most of the organic matter is of within-lake origin. Furthermore, there is no perennial run-off flowing into the lake and the materials which could be transported into the lake are limited. This statement has been added in section 6.2 (P.17, L.385-391).

Chen, S.Q., Liu, J.B., Chen, J.H., Wang, H.P., Wang, Z.L., Rao, Z.G., Xu, Q.H., and Chen, F.H.: Evolution of integrated lake status since the last deglaciation: a high-resolution sedimentary record from Lake Gonghai, Shanxi, China, Palaeogeogr. Palaeoclimatol. Palaeoecol., under review.

Meyers, P.A. and Ishiwatari, R.: Lacustrine organic geochemistry—an overview of indicators of organic matter sources and diagenesis in lake sediments, Org. Geochem., 20(7), 867-900, 1993.

Finally on p. 15: The temperature preferences of chironomids in Norway has questionable relevance to a Chinese record.

Response: Many thanks for this reminder. The previous statement has been revised. Given that *Stictochironomus* and *Procladius* were abundant in this stage as well as in the mid-Holocene (*H.P. Wang et al., 2016*), the environment during this stage may have been relatively warm. This is similar to a record from Norway which showed that *Stictochironomus* and *Procladius* indicate a relatively warm environment. Thus, we use the Norway record as a reference for the assessment (P.16, L.355-359).

Wang, H.P., Brooks, S.J., Chen, J.H., Hu, Y., Wang, Z.L., Liu, J.B., Xu, Q.H., and Chen, F.H.: Response of chironomid assemblages to East Asian summer monsoon precipitation variability in northern China since the last deglaciation, J. Quat. Sci., 31(8), 967-982, 2016.

P. 17: The statement that two reconstructions "were chosen for comparison" worries me. In response to such statements I always worry: were these records selected objectively? Was this choice biased, instead selected because these records best support the author's narrative?

Response: These records were selected objectively. We added more description about the process of records selection in the revised manuscript (P.18, L.400-406). In this study, all the Holocene temperature reconstructions over China were collected for comparison. However, many of the

records are problematic in that they have a large dating uncertainty, low resolution or are environmentally ambiguous. Only two unambiguous and high-resolution temperature reconstructions were finally chosen for further comparison due to their precise high-quality dating which was the most important selection criterion used in this study.

P. 18: The statement, "The foregoing demonstrates that our chironomid-based temperature reconstruction is reliable", is not supported by independent evidence. Such a statement requires very strong, independent evidence.

Response: We agree that the previous statement needs strong and independent evidence. Given that our results show a good consistency with other reconstructions, the previous statement has been corrected as "The foregoing demonstrates that our chironomid-based temperature reconstruction is reasonable and representative" (P19, L432).

also on p. 18: On what basis can the chronology be described as robust? This adjective likely reflects bias and overstatement.

Response: The previous statement "the robust chronology" has been revised as "the precise, high-resolution chronology" (P.19, L.434), and more details about the chronology have been added in section 3. The age-depth model for Gonghai Lake core GH09B (*F.H. Chen et al., 2015*) was used in in this study. Figure 2 shows the chronology for the last 4000 years. In the age-depth model of GH09B, 25 accelerator mass spectrometry (AMS) ^{14}C dates were obtained from terrestrial plant macrofossils, calibrated using the IntCal09 calibration curve (*Reimer et al., 2009*), and used for Bayesian age-depth modelling (*Bronk Ramsey, 2008*).

Bronk Ramsey, C.: Deposition models for chronological records, Quat. Sci. Rev., 27, 42-60, 2008.

Chen, F.H., Xu, Q.H., Chen, J.H., Birks, H.J.B., Liu, J.B., Zhang, S.R., Jin, L.Y., An, C.B., Telford, R.J., Cao, X.Y., Wang, Z.L., Zhang, X.J., Selvaraj, K., Lü, H.Y., Li, Y.C., Zheng, Z., Wang, H.P., Zhou, A.F., Dong, G.H., Zhang, J.W., Huang, X.Z., Bloemendal, J., and Rao, Z.G.: East Asian summer monsoon precipitation variability since the last deglaciation, Sci. Rep., doi: http://dx.doi.org/10.1038/srep11186, 2015.

Reimer, P.J., Baillie, M.G.L., Bard, E., Bayliss, A., Beck, J.W., Blackwell, P.G., Ramsey, C.B., Buck, C.E., Burr, G.S., Edwards, R., Friedrich, M., Grootes, P.M., Guilderson, T.P., Hajdas, I., Heaton, T.J., Hogg, A.G., Hughen, K.A., Kaiser, K.F., Kromer, B., McCormac, F.G., Manning, S.W., Reimer, R.W., and Richards, D.A.: Intcal09 and Marine09 radiocarbon age calibration curves 0-50,000 years cal BP, Radiocarbon, 51(4), 1111-1150, 2009.

Further on p. 19: On what objective basis can we conclude that this is “a detailed record of temperature changes”, as opposed, for example, to a detailed record of noise in the temperature reconstruction?

Response: Thanks for this comment. The previous statement “(iv) the high-resolution record provides a detailed record of temperature changes” has been deleted.

P. 22: The statement that “Chironomids are a stenotypic and sensitive temperature proxy” does not appear to be well supported by this study. Stronger evidence can be found in earlier research by other authors.

Response: Many thanks for the reminder. The statement that “Chironomids are a stenotypic and sensitive temperature proxy” was found in earlier research by other authors, and it has been deleted in the revised manuscript.

Overall: This is an interesting paper, but it is marred by the author’s apparent bias(es) with respect to the analysis and interpretation.

Response: Many thanks for your comments and suggestions. We appreciate all your efforts to improve this paper. All biases with respect to the analysis and interpretation, some of which may have resulted from our inappropriate expression, have been deleted or corrected in the revised manuscript.

Technical comments:

Throughout: Chinese surnames are less diverse than in other countries, which creates some problems when trying to match citations in the text with the reference list. To circumvent this issue, it is customary in most journals for in-text citations to include the given name initials for very common surnames (i.e., instances where two or more first authors share the same surname). See notes on edited manuscript.

Response: Many thanks for this suggestion. All citations with common surnames, including Chen, Liu, Wang, and Zhang, have been supplemented with first name initials. Please refer to the revised manuscript.

The authors are overly reliant on the use of undefined acronyms in the manuscript text. This detracts from the paper's readability, especially for non-specialists. Example acronyms include GDGT, YD, and STWP.

Response: Many thanks for the reminder. All undefined acronyms in this study, including EASM, GDGTs, STWP, MWP and LIA, have been defined in the revised manuscript when they occurred for the first time.

The figures should be numbered in the same order as cited in the text. This should be corrected. For example, Fig. 3 is cited (p. 6), before Fig. 2 (p. 8); and Fig. 6 (p. 13), before Fig. 5 (p. 17).

Response: Many thanks for your kind reminder. To make sure that the figures were cited in the same order in the text, **Chronology** has been moved behind **Regional setting** (P.6-7, L.130-139), and the previous statements about the modern training set in **Regional setting** have been moved to the second part of **Materials and methods** as a brief introduction of the training set (P7, L.154-157). The previous Fig. 5 and Fig. 6 have been re-ordered as Fig. 6 and Fig. 5 in the revised manuscript, respectively (P.40-41). The corresponding manuscript text has been corrected accordingly.

p. 24: Regarding Brooks et al. reference order: Papers with three or more authors should appear in the reference list after two-authored papers. Papers with three or more authors, and the same senior author, should be listed chronologically.

p. 25 & 26: Regarding J.H. Chen et al. and Heiri et al. reference order: Papers with three or more authors, and the same senior author, should be listed chronologically.

p. 27: Regarding Liu et al. reference order: Papers having senior authors who share the same surname, should be organised alphabetically, by the initials of the senior author's given name(s).

p. 30: Regarding E.L. Zhang et al. reference order: Papers with three or more authors, and the same senior author, should be listed chronologically.

Response: Many thanks for your kind reminder. These problems have been corrected in the revised manuscript.

Please also note the supplement to this comment:

https://www.clim-past-discuss.net/cp-2017-126/cp-2017-126-RC1-supplement.pdf

Response: Many thanks for the helpful notes. All mistakes have been corrected. Please refer to the revised manuscript.