Dear editor,

Please find enclosed our point-by-point responses to the questions and comments of the reviewer for **CPD** "*Characteristics of cold-warm variation in the Hetao region and its surrounding areas in China during the past 5000 yr"* by M. Li et al.

We would like to thank the reviewer for the helpful and constructive comments, the valuable propositions and suggestions on our manuscript. They helped very much to improve the quality of our paper.

The manuscript has been revised, we have answered to the comments and suggestions of the reviewer (answers are given in italics) and included his/her suggestions in the revised version.

On the behalf of all authors

Yours sincerely

All authors

Response to Reviewer's comments (cp-2009-67)

Reply to comment1

1. Six proxy records were used to reconstruct an integrated series for the past 5000 years in this study. Two of them, however, lack the segment of the last 2000 years, and one lacks that of the last 3000 years. What is the reason for such lacks? If it is in the case that sedimentary hiatus or post-depositional erosion occurred during the last two to three millennia in the relevant localities, the availability of these three records to the integration may be problematic. Although the time period in this study pertains to the past 5000 years, the last 2000 years would be paid more attention than the first 3000 years of the past 5000 years.

Reply: The name of two series which are lack the part of the last 2000 years is Diaojiaohaizi Lake Sediment (DJ) and Huangqihai Lake Sediment (HQH); and the name of the third series which are lack of the data during the last 3000 years is Zhuyeze Lake Sediment (ZYZ).
For ZYZ series: the authors of the origin paper only discuss the climate change during 9-3 kyr BP , because the upper sediment record (dating recent 3000 years)was affected by human activity.

For HQH series: there are a large number of plant roots in the upper section of Huangqihai Lake Sediment which was disturbed by human, so the authors of the origin article did not reconstruct the temperature change during the past 2000yr, which came from the soil sampling between the ground surface and a depth of 150cm below

For DJ series：the lake sediments are well preserved and consist of clay and peat. The dated length of the Diaojiaohaizi Lake Sediment is from 10175 yr BP to 2100 yr BP. So the proxy series lack the segment of the last 2000 years.

To evaluate the result during the past 2000 years that we reconstructed in this manuscript, and focus on the climate change process during this important stage, a comparison between the different series was conducted. It included the series reconstructed from the Hetao and its surrounding area, the Qilian mountain temperature series (Liu et al., 2007) from tree-ring, and temperature reconstruction for western north of China from historical documents (Hao et al., 2009). The comparison figure was plotted in Fig.4 between line 5 and 6 on page 10 in our manuscript.

2. The integrated series in this study is derived from proxy records and referred to as temperature index. Judging by the original indices used for the integration, four of them (oxygen isotope, organic carbon, magnetic susceptibility and carbonate content) are geological proxies except for the temperature index itself from two proxy records. To what extent, do these proxies represent temperature? Is there any possibility to extract the temperature signal from each geological proxy so as to convert the proxy curves to the temperature ones?

Reply: Oxygen isotope: Precipitation in northwestern China is less than other part of China. In addition, the related mechanism research conformed that temperature has a significant effect on the change of oxygen isotope in inland lake. When the temperature increases, the lake water vaporize, the value of oxygen isotope becomes higher; it becomes lower when the temperature decreases. So the change of oxygen isotope value represented temperature warm/cold.

Organic carbon: Because the studied area locates the semi-arid region, and lies in the entrance of cold wave, the organic carbon in section of this region is more sensitive to temperature than

precipitation. the value of organic carbon indicates the warm-humid and cold-arid variation of climate, it contains the temperature signal, but the temporal resolution is low (about more than 100 years), so the temperature signal can not be extracted. The magnetic susceptibility and carbonate content are as well. These proxies are used for indicating the warm-humid and cold-arid variation in other area, like Qinghai Lake et al (Liu et al, 2003).

3. In Section 4, the authors compared the reconstructed temperature series in this study with the other ones from China and the other regions of the Northern Hemisphere. It may be more necessary to discuss the differences among the proxy records used in the integration and as well the reason behind such differences prior to regional comparisons. To do so would help the readers to understand the reliability of the reconstructed temperature series.

Reply: we added "But the 6 series have different temporal resolution, and there are difference about climate change revealed by the 6 series in terms of type of natural archive and their correlation with temperature." in line 4 on page 5.

4. Yikezhaomeng and Zhuyeze are differently abbreviated in Table 1 and Figs. 1 and 2.

Reply: We have revised it in manuscript according this advice. LZL to ZYZ in Table 1. YM to YK in Fig 2.

Reply to comment2

1) Materials Two of six palaeo records are presented as temperature variability, and the others (oxygen isotope, total organic-carbon, magnetic susceptibility and carbonate-content) as climate proxies. However, temperature is not the sole factor influencing those proxies. Other factors, e.g. precipitation and evaporation, may also play an important role in variations of the proxies. Therefore, it is necessary to fully evaluate the relative contributions of the temperature to each proxy prior to quantitative temperature reconstruction.

Reply: Oxygen isotope: Precipitation in northwestern China is less than other part of China. In addition, temperature has a significant effect on the change of oxygen isotope in inland lake. When the temperature increases, the lake water vaporize, the value of oxygen isotope becomes higher; it becomes lower when the temperature decreases. So the change of oxygen isotope value represented temperature warm/cold.

Organic carbon: Because the studied area locates the semi-arid region, and lies in the entrance of cold wave, the organic carbon in section of this region is more sensitive to temperature than precipitation. the value of organic carbon indicates the warm-humid and cold-arid variation of climate, it contains the temperature signal, but the temporal resolution is low (about more than 100 years), so the temperature signal can not be extracted. The magnetic susceptibility and carbonate content are as well. These proxies are used for indicating the warm-humid and cold-arid variation in other area, like Qinghai Lake et al (Liu et al, 2003).

To evaluate the result during the past 2000 years that we reconstructed in this manuscript, and focus on the climate change process during this important stage, a comparison between the different series was conducted. It included the series reconstructed from the Hetao and its surrounding area, the Qilian mountain temperature series (Liu et al., 2007) from tree-ring, and temperature reconstruction for western north of China from historical documents (Hao et al., 2009). The comparison figure was plotted in Fig.4 between line 5 and 6 on page 10 in our manuscript.

Page 5, lines 2-4, the authors stated that "6 reconstructions from different proxy archives represent temperature changes and explain between 83% and 94% of annual temperature variability in 1951-2007". Why?

Reply: the range from 83% and 94% is each grid data series's variance explaination for the whole region temperature series during 1951-2007.

2) Methods Page 6, line 10, how many grids is the studied region divided into? Is n (the number of grids) in equation (1) the same with that in equation (4)? A modern surface annual-temperature in each grid area can be calculated using climatological data during 1951-2007 from weather stations. However, for palaeo data, except for the grid areas where six proxy data are located, how to determine temperatures in other grid areas?

Reply: The studied region can be divided into 55 grids. n in equation (1) is not the same with that in equation (4). n is a variable, not a fix quantify. To differentiate them, we have changed "n" in equation (4) with "m".
In the paper, we composite the series using 6 series according to the methods of "arithmetic average" and "weighted average", and we do not think over other grid areas, because the area we studied is small, there is not big temperature difference in this region.

Page 7, line 1, "Before averaging, each series is standardized". How did the authors transfer the proxy variations, oxygen isotope, total organic-carbon, etc., to temperature series?

Reply： Each series was standardized to a dimensionless temperature proxy index series that reflected the temperature variation amplitude, in order to compare and integrate among of the different series. They are not temperature value series.

3) Results and discussion i) Since the combined 5000-yr temperature record is based on several sites including Daihai and Jingbian, it is inappropriate to compare the temperature record again with the palaeoclimate records from these sites. It is arguing in a circle. ii) The 5000-yr-long temperature reconstruction was divided into seven stages and different stages were correlated with various palaeorecords from different sites, including southern China, Finland, Iceland, the North Atlantic, etc. This is not a good scientific logic and the conclusion based on such correlation is not convincing. If the authors want to compare their temperature record with palaeoclimate records from other sites, they should put all of them in the whole time interval and to discuss the similarity, difference and their possible causes.

Reply：i）we agreed the reviewer's suggestions, and have deleted "Obvious evidence of this are in Diaojiaohaizi Lake(DJ), Yikezhaomeng salt lake (YM), Daihai Lake (DH) and Jingbian County (JB) ofChina (Fig. 2)"in line 3-5 on page 8, "This cold event was very obvious in Daihai Lake (DH) and Diaojiaohaizi Lake (DJ) in China (Fig. 2)" in line 14-15 on page 8, "as showing in Jingbian (JB) and Daihai lake area(DH) (Fig. 2)" in line 27-28 on page 8, and "; that was very obvious in Jingbian area (JB) during this time period (see Fig. 2)" in line 5-6 on page 9.
ii) A comparison of series reconstructed for the Hetao and its surrounding area and the Qilian mountain temperature (Liu et al., 2007) reconstructed by using tree-ring and temperature reconstruction for western north of China using historical documents(Hao et al., 2009) in Fig.4.

Technical corrections Page 3, lines 23-24, "9 samples were dated using radiocarbondated method". The authors gave wrong information here. Although Xu et al. (2003) stated that nine

samples were dated in the text, only eight samples were listed in Table 1. A relevant paper also shows eight radiocarbon ages in sediments of Daihai Lake (Xiao et al., 2004, QSR).

Reply: we changed "9" in line 23 on page 3 with "8" according to the referee's suggestion.

Reply to comment3

1. For the temperature reconstruction, it is very important that the proxy can represent the temperature changes, but the variations of the total organic carbon in loess section, magnetic susceptibility and carbonate content in lake sediment are not only affected by temperature, but also by precipitation. So the authors should give the evidences to support the changes of these proxies due to temperature.

Reply: Organic carbon: Because the studied area locates the semi-arid region, and lies in the entrance of cold wave, the organic carbon in section of this region is more sensitive to temperature than precipitation. the value of organic carbon indicates the warm-humid and cold-arid variation of climate, it contains the temperature signal, but the temporal resolution is low (about more than 100 years), so the temperature signal can not be extracted. The magnetic susceptibility and carbonate content are as well. These proxies are used for indicating the warm-humid and cold-arid variation in other area, like Qinghai Lake et al (Liu et al, 2003).
To evaluate the result during the past 2000 years that we reconstructed in this manuscript, and focus on the climate change process during this important stage, a comparison between the different series was conducted. It included the series reconstructed from the Hetao and its surrounding area, the Qilian mountain temperature series (Liu et al., 2007) from tree-ring, and temperature reconstruction for western north of China from historical documents (Hao et al., 2009). The comparison figure was plotted in Fig.4 between line 5 and 6 on page 10 in our manuscript.

2. For the time resolution, it is based on the sampling of interval in profile and the flux of sediment, not the data interpolation. Generally, the loess profile could be used for 1000 yr resolution on climate changes because of the erosion by surface water, not enough for the 100 yr resolution.

Reply: the time resolution of Jingbian County series (JB) is 100 years because the interval of sampling is short enough as recorded in the original paper, which has fine time resolution than other loess profile. But the result that we reconstructed in our manuscript is believable in comparison with high temporal resolution proxy series including tree-rings and historical documents.

3. For the conclusion about "on the century to multi-century scale…… Did not occur simultaneously in different regions" in the last section. Why? Please add more discussion on it.

Reply：The climate are affected by regional atmospheric circulation, regional landform, et al, so it will induce that the beginning and the ending time of a climate event varies from region to region. Please refer to line 18 on page 10.

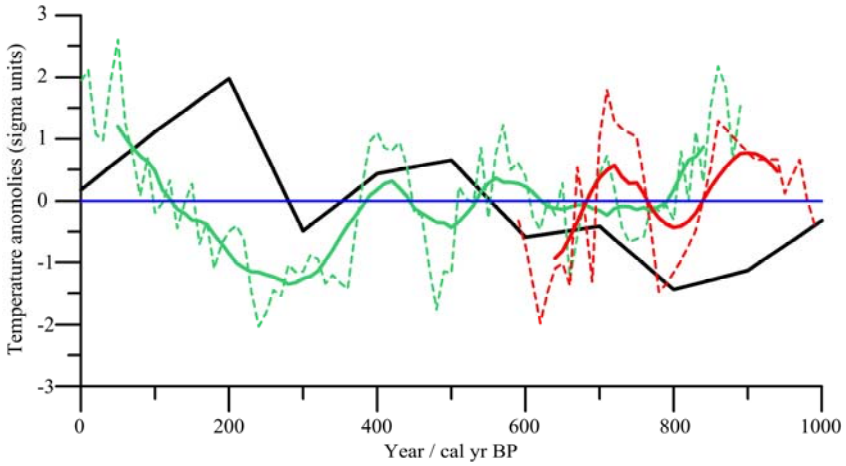

Fig. 4. Comparison of three temperature reconstructions for China. Black curve: temperature series reconstructed in the paper; Green dashed line: 10-yr average temperature changes reconstructed by using tree-ring in Qilian Mountain (Liu et al, 2007); Green curve: 100-yr smoothing average temperature records in Qilian Mountain; Red dashed line: 10-yr average temperature record reconstructed by using history record and natural evidence in eastern part of North West China; and Red curve (Hao et al, 2009): 100-yr smoothing average temperature record in eastern part of North West China.

The following paragraph was added between line 5 and 6 on page 10:

In addition, the correlation coefficient of temperature records of Zhangye meteorological station and Hetao region from 1956 to 2009 is 0.936, and the tree-ring width and temperature data from Zhangye meteorological station have a closer relation (Liu et al, 2007). Therefore, the tree-ring width indicated the temperature changes in Qianlian Mountain. A comparison of series reconstructed for the Hetao and its surrounding area with the Qianlian mountain temperature series (Liu et al., 2007) from tree-ring, and temperature reconstruction for western north China from history documents(Hao et al., 2009) in Fig.4. The Figure4 shows that the temperature changes of the Hetao and its surrounding area shows good agreement with that of the Qilian Mountain and of eastern part of North West China. But there are difference in some stages, such as about 500 yr BP, it may be induced in terms of different proxy archives.

The new references we have added in:

Liu, X. Q., Shen, J., Wang, S. M., et al.: A 16000-year Paleoclimatic record derived from authigenetic carbonate of lacustrine sediment in Qinghai Lake. Geological Journal of China Universities, 9, 38-46, 2003.

Hao, Z. X., Ge, Q. S., and Zheng, J. Y.: Temperature variations during the song and Yuan Dynasties (960~1368 AD) in the eastern part of North West China. Quat. Sci., 29, 871-879, 2009. *Please refer to between line 26 and 27 on page 11*.

Liu, X. H., Shao, X. M., Zhao, L. J., et al.: Dendroclimatic temperature record derived from tree- ring width and stable carbon isotope chronologies in the Middle Qianlian Mountains, China. Arct. Antarct. Alp. Res., 39, 651-657, 2007. *Please refer to between line 11 and 12 on page 12.*