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## ***Interactive comment on “Millennial Minimum Temperature Variations in the Qilian Mountains, China: evidence from Tree rings” by Y. Zhang et al.***

**Y. Zhang et al.**

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The major changes we made in this revision:

- 1) We update the latest instrumental data and CRU data (1951-2011 to 1951-2012).
- 2) We changed the MTM spectrum analysis to Wavelet analysis according to the reviewers' comments, and cancelled the partial correlation analysis, adding the results of split-sample calibration verification analysis, as well as the detailed description section on Selecting and building regression models.
- 3) We used the mean temperature to reconstruct the past temperature history instead of minimum temperature, and meanwhile employed the split-sample calibration verification methods to evaluate the regression model instead of leave-one-out methods.(p.10-12)
- 4) We performed additional analyzes on the relationship between ENSO and reconstructed temperature us-

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ing moving-correlation. (p.18) 5) Because we finally reconstructed the July-September mean temperature, the title was changed to “Millennial Mean Temperature Variations in the Qilian Mountains, China: Evidence from Tree rings”

Reply on the comments

Comment1:My main general concern is the focus on the minimum temperature. It is mentioned in a few places that correlations between tree-ring width (TRW) and mean temperature are nearly as high as correlations between TRW and minimum temperature. Is there a tree physiological reason why growth should be related to a monthly temperature minimum that possibly covers just a very short period of the entire month? Or are minimum and mean temperature just very highly correlated and minimum temperature shows coincidentally slightly higher correlations? Also, why should temperatures from January to April influence growth? Maybe due to extended snow cover? The choice made in this manuscript seems to be just a statistical hunt for highest correlation and I miss a sound scientific argumentation for the choices that have been made. It is mentioned only once in section 3.3 that the authors reconstruct “monthly minimum temperature anomalies, averaged over the months January to August”. I found the mostly used term “mean minimum temperature” not very clear. Finally in the comparison with other records, the minimum temperature reconstruction is discussed as if it would be exactly the same as a mean temperature reconstruction. Therefore, I would suggest to either focus on the mean temperature reconstruction instead of the minimum or at least show more results for how minimum and mean temperatures are related and then explain a possible mechanism why trees should respond to one temporally short monthly minimum or an average of a few monthly minima rather than average temperatures during the growing season.

REPLY: thank you very much for your constructive comments. In the revision, we employed the July-September mean temperature to reconstruct the past temperature history. Additionally, some information is needed to add here. Because the elevations of the two stations are quite different, the climate data should be normalized or anomalied

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before calculating the average. The correlation coefficient between mean temperature and minimum temperature in 12 months are very high with the inter-correlation value of 0.88. Considering the test results of leave-one-out and split-period method, we chose the average January-August minimum temperature of both stations to reconstruct the temperature variations for the past millennium in the first version. In addition, higher temperatures from January to April will reduce the risk of freeze injury and extend the growing period. The influences of snow cover maybe less in our study area because less snow will be retained under the strong wind in the higher elevation, especially in south slope. However, we finally employ the July-September temperature considering the possible influence of late spring and early summer precipitation on tree growth.

Comment2:My second general concern is in regard to the spectral analysis. The strongly autocorrelated TRW is expect to have a red spectrum. Much more details about the applied method are needed, for instance with regard to how the red spectrum is taken into account in the decision which frequencies show significant peaks. I would be very careful trying the discuss a 500-yr cycle. Data treatment such as detrending might have influenced the low-frequency variability of the reconstruction, especially if chronologies have a length of around 500 years. You should also check how the 20th century temperature trend influences the spectral characteristics.

REPLY: Considering the reviewers' comments, we employed the wavelet analysis instead of MTM analysis. The 500yr is less certain because of the boundary effect, we didn't discuss it in the revision. In the first version, we used the mtm10c\_XP.exe program downloaded from Lamount tree ring lab, which is widely used in tree ring researches. In this program, we used red-noise spectrum with F-test.

Comment3:Finally, not all readers of "Climate of the Past" will be experts in tree-ring research. Thus, I strongly suggest to explain the methods and statistical skill measures in more detail, e.g.what is a "response function", "subsample signal strength", "Rbar", "EPS", etc. and how are these interpreted.

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REPLY: thank you for your advice, some explanations have been added in the revision.(see the detailed at line 19-20, page 33 and line 14-16,page 7), but not all of them, because some methods can not express completely with a few words. However, the following is the detailed information of these methods and statistical skill: Response Function analysis (Fritts et al., 1971; 1974) is a multiple regression technique using the principal components (PCs) of monthly climatic data to estimate indexed values of ring -width growth. The regression coefficients are then multiplied by the PCs of climate to obtain a new set of regression coefficients related to the original monthly climatic data variables. The technique has become widely used to estimate how ring -width growth (portrayed by a particular standardized chronology) responds to variations in monthly climatic conditions over the span of a year or more. Expressed Population Signal (Wigley, 1984): the chronology signal, expressed as a fraction of the total chronology variance, then quantifies the degree to which this particular sample chronology portrays the hypothetically perfect chronology. This has been termed the EPS. And EPS is not often a constant over the different parts of a chronology. It is important to appreciate the degree to which EPS varies through time as a function of variations in correlation coefficient( $r$ ) and series replication. The SSS(Wigley, 1984) estimates the agreement between an average series made from a few samples with one made from an optimum or larger number of series. The  $R_{bar}$  is mean inter-series correlation

#### Detailed Comments

Comment4:Page 342 Line 6: “pre- and current growing season” You just analyze the previous year starting in October when the growing season was probably already finished!

REPLY: maybe there are some misunderstandings, this sentence indicated the correlation results between temperature and tree ring index.

Comment5:Line 6: “with minimum temperature” do you mean daily or monthly or yearly or : : minima? Line 18: “28.8-66.2, 113.6-169.5” wide ranges of significant peaks, see

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also general comments on spectral analysis above.

REPLY: because the content has been modified largely, these sentences have been deleted.

Comment6:Line 21: Last sentence is very vague

REPLY: this sentence has been change to “The Comparison between reconstructed temperature and the index of tropical volcanic radiative forcing indicated some cold events recorded by tree ring may be due to the impact of tropical volcanic eruptions.”

Comment7:Page 344 Line 5: “different with those” -> “different from” or “in comparison to”

REPLY: yes, it was modified.

Comment8:Line 11” Why was it controversial if samples where temperature or precipitation sensitive?

REPLY: because most samples are archaeological samples from tomb, there are less information about the sources of these ancient wood, some researchers think them temperature sensitive, while other think them moisture sensitive.

Comment9:Line 14 ff: “Whether : : :” TRW reconstructions, which have to be detrended and otherwise statistically treated, have been shown to often not properly capture the full spectrum of climate variability. Will they be able to answer that question here?

REPLY: Based on our reconstruction, the increase of temperature during the most recent 100 years was the most rapid in the past millennium with a warming trend of 0.26°C per 100 years, and the most recent 50 years was the warmest period for the past1300 years.

Comment10:Line 27: “We hope” I would use another expression

REPLY: it changed to “This reconstruction should improve our understanding of tem-

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perature variability in the north-eastern TP for the past millennium.”

Comment11:Page 345 Line 14: -1.5 to – 0.7 Line 23: “healthy” -> “living” and maybe say a word about the age distribution

REPLY: these words have been modified.

Comment12:Page 346 here you say the mean correlation between all cores would be 0.6. In Table 2 you write 0.312. What is correct?

REPLY: the first correlation of 0.6 is the result using Cofecha program with 32-yr spline for filtering, where all the samples were included for crossdating. The second correlation of 0.312 is the result using Arstan program with different detrended curves, where some higher sensitive series have been excluded for developing the chronology.

Comment13:Line 20: How can a growth trend be corrected with a horizontal line? In general say why many different function had to be used to remove the growth trend and how you have chosen the functions.

REPLY: firstly, we recorded the diameter at breast height when we sampled the trees. And then, before fitting the growth trends, all measurements were listed in several figures using TSAP program for the same interval to identify the growth trend of each series. For some incomplete no-pith cores from old trees and dead trees, the starting year is far from the year of pith, the growth trend is similar to a horizontal line, especially for those Qilian Juniper older than 700 years.

Comment14:Page: 347 Line 6: Maybe add a note on how these stations on very different elevations compare and why you also choose the station at so much lower elevation than the tree-ring site.

REPLY: Yes, in the revision, we add some detailed information and explanation for Zhangye station, see the detailed in section 3.3, page 9-11.

Comment15:Line 11: Is there no way to obtain data from the closed station if there is

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one existing?

REPLY: Yes, we have the instrumental data in the closed station (Sunan station), but the data interval covered from 1957-2010, and meanwhile, this station is not the first class station, we can't obtain the latest data through official avenues.

Comment16:Page 348 Line 2: "Compare : : ." sentence is not clear. Line 4: "subset of 2-station means" do you mean a subset of certain months?

REPLY: in the revision, we didn't employ the average value of the two stations, therefore, the paragraph including these confusing sentences was deleted.

Comment17:Line 15: "is derived" Line 19: "covers" Line 22: "mean" before you said it would be the "median" Page 349 Line 16 to 20: delete, just repetition of previous paragraph Line 21: "correlation" Line 21: rephrase, not clear that you generate a mean of the two stations for all temperature variables. Line 23: What is "mean Tmin" Line 26: Why?

REPLY: these words have been modified in the revision.

Comment18:Page 350 Line 2: Is Tmean also significant?

REPLY: Tmean is also significant in different months and multi-month periods, therefore, we used Tmean in the revision.

Comment19:Page 351 Line 8: Do you have any indication for issues with early instrumental data?

REPLY: some records from China Meteorological Administration showed most stations in northwestern China have been moved, but it is not mentioned in the first version. However, the data from China Meteorological Administration have been checked and accessed data quality.

Comment20:Page 354 Line 8: Has Qilian data been degraded to 3-yr averages before calculating correlations?

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REPLY: Yes. The correlation is significant ( $p < 0.01$ ) after degrees of freedom adjustment.

Comment21: Line 27: “inner-year” -> “intra-annual” ?

REPLY: yes, it is modified.

Comment22: Page 356 Line 12 ff: Why do you discuss the ENSO cycle extensively if you do not find any correlation between ENSO reconstructions and your temperature reconstructions but you do not discuss cycles in thermal contrasts, westerlies, etc. although you briefly mention them as possible causes of the observed frequencies? Line 26: or it means that ENSO is not responsible for the 2-yr frequency!

REPLY: In the revision, we found the relationship between the ENSO and temperature varies with time using 50-yr moving correlation, some significant correlations were found in several periods, especially in the periods when the 2-4 yr. cycles is prominent, please see the detailed in line 4-9, page 18. “while some significant correlations between ENSO index and reconstructed temperature were found in some periods using 50yr moving-correlation. A series of significant positive correlations ( $p < 0.01$ ) were found in approximately AD 1340-1410, 1553-1631, and 1798-1869, the highest correlation coefficient was 0.32 in AD 1355-1404, and meanwhile, continuous significant negative correlation ( $p < 0.01$ ) were found in AD 1060-1130, 1591-1656, and 1840-1927, with the highest correlation coefficient of -0.33 during AD 1849-1898.” Line 16: “has been” -> “can be identified”

Comment23: Page 357 Line 15: Do you mean the 11-yr sun spot cycle when you talk about the 22-yr cycle?

REPLY: no, we made a wrong expression, it should be “low temperatures during the LIA should be linked to the Maunder Minimum of solar activity (Shindell et al., 2001)”

Comment24: Page 358 Line 10: delete “to us” Maybe mark the 21 volcanic eruptions in the reconstruction plot Page 359 Line 19: “relationships” Figures Check label sizes,

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very different sizes make small text hard to read in the current printer-friendly pdf version. Figure 1 Strange odd numbers on elevation scale Figure 3 Rbar has not been explained in text Figure 4 Maybe just show the average of the two stations as all there parts of the plot are very similar Figure 6 Is it mean or minimum temperature? Figure 7 Labels and titles could be improved and duplicate scale removed Figure 8 Is the “temperature anomaly” (top) again the “minimum”?

REPLY: thank you very much for careful suggestions, we have modified them in the revision.

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