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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.

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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

using moving-correlation. (p.18)

Reply on the comments

Comment1: Response of Qilian juniper to climate: The authors mention two papers that reconstruct temperature using Qilian juniper. In one study Qilian juniper ring-widths reflect December to April temperatures, in the other study ring-widths reflect previous September to April temperatures. In this study January to August temperatures are reconstructed. Qin et al. (2013) find precipitation to be limiting for growth of Qilian juniper. Could the authors explain why Qilian juniper is sensitive to so different climate variables in different places? The authors provide a short discussion in chapter 4.1. I think this manuscript would greatly benefit from further explanations.

REPLY: As mentioned in the manuscript, the reconstruction of December to April temperature (Liu et al., 2007) was developed in the Qilian Mountains near to our study area, using the ring widths and stable carbon isotope ratios (13C) of Qilian juniper with 3-yr resolution, while the reconstruction of September to April (Zhu et al., 2008) was conducted in Wulan approximately 200 km south of our sites. Although the reconstructed periods were different, all chronologies were temperature-sensitive. Actually, tree-ring growth in this study site were also significantly correlated with temperature in same periods, which can be proved in Table 3 in the revision, however, we think the July-September mean temperature is a better choice in this research. The precipitation signal found in upper-limit of Qilian Juniper (Qin et al., 2013) is in contradiction with others. From my options, three reasons can be used to explain such disagreement: firstly, it seems that the highest sample site did not reach the upper limit of Qilian Juniper in this area (Delingha). Based on our lots of fieldwork, the upper limit of Qilian Juniper in this place is ranged from 4200-4350, which is 200 meters higher than the elevation presented in Qin's work; Secondly, the climate in this area is dry, in some extremely dry years, tree growth will be influenced by precipitation in any different elevations, and in general years, most of trees are moisture-sensitive in lower and mid-higher elevations, that is why the precipitation signal can be found easily in many researches; finally, the slope is so steep(40-60°), and the tree standing is dry environment with some rock, in this case, tree ring will preserve more precipitation information. In addition, as we know, the climate, topography and geomorphology in Mountain area are obviously distinct in different place with different elevations. Qin's study was carried out in a single slope, the spatial representation might be weak. According to the comments, some further explanations were added in Line2-3,P11, the following is the detailed: "Based on the phonological investigation of Qilian Juniper in the Qilian Mountains (Liu et al., 2006), the Qilian Juniper leaves sprout in late May or early June when average daily temperature reaches 8-10âĎČ, radial growth will continue into middle September, and stop in late September."

Comment2:Is there a possibility to exclude changing growth limitations (seasons and from temperature to precipitation) during the reconstruction period?

REPLY: Exclude changing growth limitations maybe mainly depend on the appropriate sampling strategy and critical sample selection. If we want to find some temperature-sensitive samples, trees living at higher elevation, gentle slope and good soil conditions will be better choice.

Comment3:Figs 3 and 7(a): The period 1925-1940 looks very interesting. The ring-width chronology experiences a massive trend and inter-annual variability seems rather low (as far as this is visible from the figure). Is this trend as well found in other tree ring series? Why is the inter-annual variability so low? Could the authors expand on this very interesting period?

REPLY: the lower inter-annual variability was also found in other reconstruction, not only in the Qilian Mountains but also in southeast part in the Tibet Plateau(Zhu et al., Palaeogeography, Palaeoclimatology, Palaeoecology, 2011), actually, the Asian regional summer reconstruction(Cook et al., Clim Dyn, 2012) showed a similar variability and trend. The inter-annual variability looks like so low in the figure, should be due to the rapidly increase of temperature during 1930-1936 (from 17.6 to 18.4âĎČ).

Comment4:Calibration issues: To me it remained unclear what (beside the highest r value) the motivation for reconstructing over an eight month period is. In this eight month period May and March are included, two months that seem (partly) precipitation sensitive. The influence of JJA temperatures on ring-width seems almost as strong as the influence of January through August temperatures. Could the authors as well calculate partial correlations for T JJA when the influence of T JFM has been partialled out, and vice versa?

REPLY: the partial correlation analysis were used to investigate the possible influence of precipitation in spring and early summer, while the July-September mean temperature was finally chosen in the revision, in some extent, the partial correlation analysis has little effect on the content with a lot of space in the manuscript, therefore, in the revision, the partial correlation analysis was cancelled instead of the results of split-period methods and some explanations of regression. However, we calculate partial correlations of T JJA with tree ring index when the influence of T JFM has been partialled out, the correlation coefficient of JJA changed from 0.65 to 0.5($p<0.05$) when considering the influence of T JFM, and vice versa, the correlation coefficient of JFM changed from 0.58 to 0.52($p<0.05$).

Comment5: P 351 lines 3-6: In an earlier section the authors mention the short calibration period that makes a split period approach impossible. In this section the authors are, in fact, splitting the calibration period in a period 1960 – 1984 and 1985 – 2011. For univariate (ordinary least squares) regression, regression parameters (a and b) and Pearson's r are directly related (b = r * sy / sx, and a = ymean– b * xmean). Therefore, I think the authors should decide whether a split period approach is possible or not. If they decide it is possible, they should use classical RE and CE statistics and as well give the correlation coefficient and p-value for the period 1960 – 1984.

REPLY: Many thanks to the valuable comments, the split period approach was employed in the revision using temperature data in Zhangye station, in which the length of instrumental data is 62 yr. In the first version, the split period method was also tried for testing the reliability of regression model, however both the mean of two station and data of single station can't pass the test at significant level of 0.05, and in the meanwhile, the January-August minimum temperature was truly meet the requirement of regression model using leave-one-out method. In the revision, although the results of split period method were similar to those in the first version, the regression model can pass the test after excluding some abnormal years and employing longer instrumental temperature data, therefore, we finally chose the split period method in the revision.

Comment6:P 351 lines 7-8: The authors mention a discrepancy between tree-ring data and meteorological data between 1960 and 1984. This discrepancy might indeed be caused by lower quality of meteorological data prior to 1985. A possibility of testing this hypothesis is to compare the (temperature) data of the two stations prior to 1985. Is the correlation between the two stations lower prior to 1985? Liu et al. (2007) don't find significant inhomogeneities among five stations including Zhangye. According to Liu et al. (2007) the Zhangye record starts in 1951 (with some missing values up to 1953). Is the data quality so low that the authors decided to omit these data?

REPLY: according to the information of site migration from China Meteorological Administration, the locations of most of stations in the northwest China have been moved before 1980. And the estimate data do match well with the instrumental data after 1985, no more reasons can explain it but the possible lower data quality prior to 1985. We omit the data of Zhangye before 1960 because the common period of Zhangye and Yeniugou station is from 1960 to 2011. Additionally, the data length and elevation of both station are quite different, that is why we used the average of temperature anomaly of both stations in the first version.

Comment7:P 351 lines 15- 20: 'Regardless the issues in the earlier part of the calibration period, the evaluative statistics in Table 3 indicated that our regression model was stable and reliable, and was acceptable to reconstruct the annual-to-centennial variability...' I do not think a leave-one-out approach is sufficient to substantiate this claim. Perhaps the authors could leave out 10 or even 15 consecutive years. Good perfor-

mance under slightly less favourable conditions would increase the credibility of the calibration model. Unfortunately, the ring-width chronology is at its high end between 1960 and 2011. Therefore the reconstructions for most of the period before 1900 are at or beyond the end of the calibration space. As mentioned by the authors temperature variations are less nicely depicted between 1960 and 1985. Considering the entire tree-ring chronology the values for the period 1985 – 2011 are all in the fourth quartile.

Reply: according to the comments, we finally used the split-period method instead of leave-one-out method.

Comment8:Page 350 line 5 why is the correlation calculated for 1962 – 2011 and not for 1960 –2011?

Reply: because the seascorr program calculates the correlation for the previous year, and it is in default in the program.

Comment9:MTM: P 352, lines 10 -14. How is the massive trend (non-stationarity) in the 20th century affecting the MTM spectrum? Could the authors run the spectral analysis for data from AD 700 to AD 1900?I am not an expert on MTM and significance tests but I nevertheless have a question on this topic: Are the significance levels indicated valid for one single test i.e. if the scientist is interested in the significance of the 11-year band, or are these levels accounting for multiple testing since all frequency bands are tested for significance? The comparison to other reconstructions and forcings isn't fully satisfactory. Many frequency bands > 10-year are significant. Since solar cycles have very wide frequency bands (DeVries–Suess cycle 170–260 year), it would be surprising if none of the significant frequencies were in the solar bands. Additionally, the use of wavelet coherence analysis is possibly a more straight forward approach for comparisons between reconstructions and forcings.

REPLY: According to the comments of reviewers, we used the wavelet analysis instead of MTM spectrum. The resulting cycles were similar with MTM spectrum analysis, but are more reasonable (section 4.3, p17-19). 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. The multi-taper method can reduce estimation bias by obtaining multiple independent estimates from the same sample. Each data taper is multiplied element-wise by the signal provide a window trial from which one estimates the power at each component frequency. As each taper is pairwise orthogonal to all other tapers, the windowed signals provide statistically independent estimates of the underlying spectrum. The final spectrum is obtained by averaging over all the tapered spectra. I am very sorry that I am not an expert on MTM too, however, Mann et al.(1996) introduced the detailed information of MTM analysis. (Mann M. E., and Lees, J.M.: Robust estimation of background noise and signal detection in climatic time series, Clim. Change, 33, 409-445, 1996.). Before using the wavelet analysis, we also try to run the MTM analysis for data from AD 670 to AD 1900, the 500yr periodicity still exists, but in the wavelet analysis, it is less certain because of the boundary effect.

Interactive comment on Clim. Past Discuss., 10, 341, 2014.