Answers to the comments

The authors would like to thank the editor and reviewers for their valuable and constructive comments that help improve the manuscript. According to their comments, two major revisions have been done as follows:

1. We added a new section as "4.1 Climate-growth relationship" considering answering the 2nd question of Reviewer#1, 7th question of Reviewer#2 and 6th question of Reviewer#3. Please see the corresponding part in the new version.
2. We moved the comparison between I_{APO} and PDSI reconstruction to the "4.4 Possible linkage with summer Asian-Pacific oscillation and solar activity", and made deeper discussion about the mechanism underlying between I_{APO} and PDSI reconstruction.

In the revised manuscript, the corrected contents according to the comments of the reviewers were shown in red, 13 new references were supplemented (listed at the end). The lines in this new version are greatly different from the original ones. The revised manuscript has incorporated all the comments raised. For detail, please refer to the answers as follows (Comments from the reviewers and editor are written in black, and author's answers appear in blue.):

Anonymous Referee #1

Received and published: 11 December 2013

The Chinese Loess Plateau is an interesting area for climate change studies. In particular, the hydroclimatatic conditions in the Loess Plateau are very sensitive to climate change. Normally, it is very difficult to find trees more than 200 years due to severe human disturbances. This manuscript made a 300-year PDSI reconstruction in the southeast Loess Plateau, showing up-to-date understanding of drought variations. This manuscript is based on standard dendrochronological methods. In general, it is well presented. I recommend its acceptance after a median revision.

Comments: 1. In the end of the Introduction, it is better to pose a hypothesis or question, proving a clue for presenting results and discussions. For example, the authors may have one question: whether did the drought severity or frequency increase in response to the warming? But, this is just one example. The authors may propose other questions.

Answer: we have posed two scientific questions at the end of the introduction and answered these questions in the revised manuscript as follows:

Questions: Results of this work would be conducive to answer the following two questions: Whether did the drought severity or frequency increase in response to the global warming? Whether the drought condition nowadays in Lingkong Mountain is unprecedented during the last three centuries?

Answers: It's visible that the severity and duration of dry or wet events seemingly strengthened after 1800 AD compared with the earlier stages, possibly due to the impact of global warming. Even so, the recent drought in 1993-2008 was still within the historical framework.

2. The authors should introduce some basic information about cambial activity of Chinese pine. Such information will be useful for explaining tree growth-climate relationships.

Answer: We added a new section in the fourth part of "Discussion" as 4.1 "Climate-growth relationship" (see following), answering both this question, the 7th question of Referee #2 and 6th question of Reviewer#3. The series numbers of the following parts in the original manuscript were according changed.

4.1 Climate-growth relationship

Lingkong Mountain belongs to the semi-arid area where annual evaporation is more than twice of annual precipitation. High precipitation during the growth season actually benefits the radial growth of tree by providing necessary water for the radial cell division and elongation, while low precipitation limited the radial growth. Inversely, increased temperature before and during the growth season inevitably strengthen the water stress by accelerating water consumption in the soil and trees through evaporation and transpiration, resulting in the formation of narrow rings, and vice versa. Reasonably, positive correlation of tree rings with monthly precipitation and negative correlations with monthly mean temperature in current growth year was identified in this study, and this climate-growth pattern was generally reported in the arid to semi-arid CLP (Gao et al., 2005; Liu et al., 2005; Cai and Liu, 2013) and other areas of northern China (Liang et al., 2007).

In the present work, monthly mean temperature from March to August exerts more important influences upon tree growth than monthly precipitation (Fig. 4), which is similar to studies in the Kongtong Mountain (Fang et al., 2012), Guiqing Mountian (Fang et al., 2010a) and the Ortindag Sand Land (Liang et al., 2007), showing the temperature-induced water stress was likely the key factor limiting tree growth. The correlation analysis between PDSI and tree-ring chronology further tested the above hypothesis. Significant correlation is identified from March to August, especially significant in May and June when the temperature is comparatively high and precipitation is very low (Fig. 2), indicating an intensified drought stress. PDSI is a measurement of dryness which was calculated based on a water balance equation, depending on not only temperature and precipitation, but also other parameters such as evapotranspiration and recharge rates. Thus, it's unsurprised that the monthly PDSI of previous year had significant influence on tree growth due to the well-known lag effect, though climatic factors in previous year (except the precipitation of September) showed weak correlation with tree growth.

Interestingly, the period of limiting months coincided with the results of cambial activity of trees in northern China. Tree-ring anatomical analysis disclosed that the radial wood formation of Chinese pine usually started at the end of April (Zhang et al., 1982), and fast growth usually happened from May to August (Zhang et al., 1982; Liang et al., 2009). Similar finding was reported from *Larixprincipis-rupprechtii*, a different coniferous species from Liupan Mountain, north-central China (Guan et al., 2007). Location of our studied sites is far south than the above reported sites, and it's warmer and wetter, therefore, it's possible that the radial growth of tree in Lingkong Mountain may start earlier.

3. The third site only includes eight cores from four trees. The author should explain why only four trees were selected. Normally, more trees are necessary for the analysis.

Answer: At the third site, trees older than 100 yr are very difficult to find, so only eight cores from four old healthy trees were collected. We explained it in the revised manuscript.

4. In this study of Lingkong Mountain, the year 1721 was identified as the third driest years, and 1719–1726 was identified as one of the dry periods during the past 306 yr. It is interesting to show this dry period. However, it is necessary for the authors to find historical documents to confirm this event and the story behind it.

Answer: We added historical documents to confirm the 1719-1726 dry event as follows:

1721 was documented as an extremely dry year in the whole region of Shaanxi province, a neighbor hood of Lingkong Mountain (Yuan, 1994). In this year, the farmers reaped nothing at harvest time due to low precipitation in spring and summer, and many people died of starvation due to this drought-induced famine. By analyzing historical documents of eastern China, Zhang (2004) identified 1721-1723 as one of the tenth typical dry period during the last 1000 yr. This drought event affected at least four provinces in eastern China, including our studied area.

5. "Possible linkage with ENSO and solar activity". Apart from frequency analysis, more analysis is necessary to support the linkage between the drought variation and ENSO/solar activity. For example, the ENSO index can be used.

Answer: We deleted the discussion between PDSI and ENSO and changed the title of this part to "4.4 Possible linkage with summer Asian-Pacific oscillation and solar activity" for two reasons: 1) Though similar 2-7 yr cycles existed in the PDSI reconstruction and ENSO series, spatial correlations didn't disclose significant correlations between the PDSI reconstruction and the SST of middle-east equator Pacific Ocean. So we should be cautious to explain the 2-7 yr cycles; 2) we found that the 2-7 year cycles also existed in the I_{APO} series (Chen et al., 2011b), and the PDSI reconstruction significantly correlated with I_{APO} series (an indicator of EASM strength), which suggested that our reconstructed PDSI variation was influenced by the large-scale land–ocean–atmospheric circulation systems. So we finally adjusted the interpretation of the 2-7 yr cycles, and moved the content related with I_{APO} to this part. Please see the revised manuscript.

Sunspots are temporary phenomena on the photosphere of the sun that appear visibly as dark spots compared to surrounding regions. It is one of the most basic and obvious phenomenon of solar activity. To further study the influence of solar activity on the drought conditions in Lingkong Mountain, the sunspot time series from 1700 to 2009 were derived from National Geophysical Data Center (http://www.ngdc.noaa.gov/) to compare with our PDSI reconstruction. The low-frequency variations of the two series, after 11 yr and 35 yr smoothing, significantly correlated with each other, $r = 0.35$ $p<0.01$) and 0.68 ($p<0.01$), respectively. As shown in Fig. 9b, dry conditions in the studied sites appeared when the sunspot numbers were low, and the contrary when the sunspot numbers were high. This convincingly supported that the dry/wet conditions in the Lingkong Mountain strongly response to the solar activity.

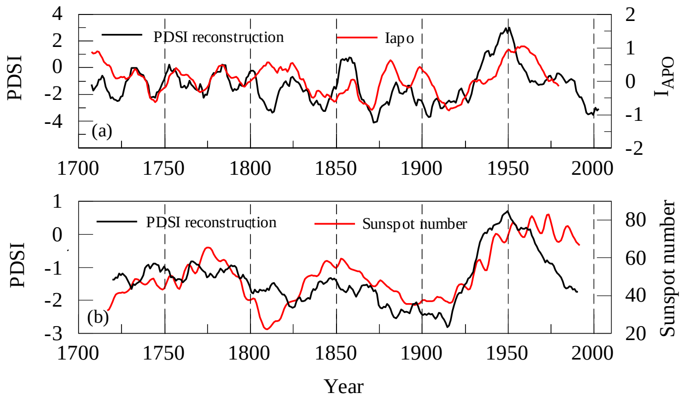

Fig. 9 (a) Comparisons (a) between the 11 yr moving average of the PDSI reconstruction and the summer I_{APO} (Zhou et al., 2009) and (b) between the 35 yr moving average of the PDSI reconstruction and the sunspot number time series.

6. It is necessary to use RE and CE to show the quality of calibration/verification.

Answer: Ok, we used split calibration-verification method to test the regression model, instead of leave-one-out method. Statistics such as R^2, RE and CE were given.

Please see the following part and corresponding content in the new version:

The fidelity of the reconstruction was verified by comparison with the Dai-PDSI data and checked by the split calibration–verification method (Meko and Graybill, 1995). Result of the split period calibration-verification test showed that the regression model is stable over time. The explained variance (R^2) for the verification period 1983-2005 was 52.1%, and reduction of error (*RE*) and coefficient of efficiency (*CE*) were 0.603 and 0.375, respectively, when the data during 1954-1982 was used to establish the regression model. R^2, *RE* and *CE* were 32.3%, 0.411 and 0.113, respectively for the verification period 1954-1973, when data during 1974-2005 was chosen as calibration. *RE* and *CE*, the two rigorous verification statistics during verification periods showed positive values, indicating sufficient similarity exists between the reconstruction and Dai-PDSI data (Cook et al., 1999).

7. Table 1 can be deleted and add one sentence in the text.

Answer: Table 1 has been deleted, and the series numbers of following “Tables” were correspondingly changed. We used split calibration-verification method to test the regression model, instead of leave-one-out method, statistics such as R^2, RE and CE were given in the text.

8. Table 3, all drought periods are indicated in a figure and it is not necessary to repeat them in a table.

Answer: Table 3 (Table 2 in the revised manuscript) showed the exact time of dry/wet periods in our reconstruction, we thought it's very useful for researchers who want to make comparison with our PDSI reconstruction in the future. So we prefer to keep it in the text.

9. PDSI is not measured. Instead, the authors can use Dai-PDSI in Fig. 5 and the text.

Answer: We’ve made such adjustment.

10. It is interesting to show the linkage between the reconstructed PDSI and the summer IAPO. A deeper analysis about the mechanism between them is necessary.

Answer: We added such analysis in the revised manuscript. See the following part and corresponding content in the text:

Theoretically, on the decadal scale rather than the annual scale, when I_{APO} was in stronger stages, the thermal contrast between eastern Asia and the North Pacific was strengthened because the low-pressure system of lower-troposphere over eastern Asia strengthens, and the western Pacific subtropical high strengthens with its location shifting northwards (Zhao et al., 2007, 2008). Therefore, lower-troposphere of the East Asian region was dominated by stronger southwesterly winds, in other words, stronger EASM, resulting in more rainfall and wet condition in North China, and vice versa.

Anonymous Referee #2

Received and published: 25 December 2013

This paper is an interesting and well-written paper on dendroclimatological study for East Asian Monsoon. I have a few minor and technical comments.

(1) Describe briefly the dendrological (2-needle or 5 needle pine? its distribution, ecophysiological setting, etc.) of Chinese pine.

Answer: We added description in the revised manuscript as follows:

Chinese pine (*Pinus tabulaeformis* Carr.), a two-needle conifer species which is endemic to China, is the most widely distributed and the most important afforestation conifer species in northern China. It generally occurs in mountain areas at altitudes of 100-2600 m (Xu, 1990). It can tolerate very low temperature (-25 ℃) and can adapt to live in low soil water availability conditions with well developed root systems. This species has been widely used for dendroclimatic researches in China (Liu et al., 2005; Liang et al., 2007; Cai and Liu, 2013).

(2) Clarify the method of crossdating; skeleton or graphic methods? or any other methods. COFECHA program is a program to verify crossdating results, not the crossdating method.

Answer: We clarified it in the revised manuscript: The Skeleton-plot crossdating method (Stokes and Smiley, 1968) was adopted to preliminarily assign the calendar years to each growth ring.

(3) page 6318 line 17: 10 'trees" may be 10 "cores' when I read Fig. 3.

Answer: Yes, it should be 10 cores. We have made correction in the text.

(4) In Fig. 5, High PDSI values during 1960s was not well predicted. It may be added in the text.

Answer: We added it in the revised manuscript.

(5) page 6322 line 10 and also Fig. 6b: I could not understand how the accumulated anomalies of PDSI was calculated. If it is not described in the Method section, add it.

Answer: We added it in the revised manuscript as follows:

The accumulative anomalies of the PDSI (AC), achieved by calculating the cumulative departure from the arithmetic mean for the period of reconstruction (Wei, 2007), can intuitively and effectively evaluate the long-term trend of dryness and wetness (Tian et al., 2007). The long-term trends of decreasing and increasing movement of AC indicate the persistently dry or wet conditions.

(6) Fig. 8: It is better to denote what "Iapo" stands for.

Answer: We explained it in the revised manuscript as following part. In addition to this, we also gave deeper analysis about the mechanism between I_{APO} and the moisture conditions in the studied area (please also see the answer to the 10th question of Reviewer # 1):

The Asian-Pacific oscillation (APO) is defined as a zonal seesaw of the tropospheric temperature in the midlatitudes of the Asian-Pacific region (Zhao et al., 2008). When the troposphere is cooling (warming) in the midlatitudes of the Asian continent, it is warming (cooling) in the midlatitudes of the central and eastern North Pacific.

(7) High correlation between tree-ring chronology and PDSI was impressive. However, I do not understand why there is rather low correlation between tree-ring chronology and precipitation. It is better to explain it physiologically.

Answer: We explained the physiological reason in the new section "4.1 Climate-growth relationship" as follows:

4.1 Climate-growth relationship

Lingkong Mountain belongs to the semi-arid area where annual evaporation is more than twice of annual precipitation. High precipitation during the growth season actually benefits the radial growth of tree by providing necessary water for the radial cell division and elongation, while low precipitation limited the radial growth. Inversely, increased temperature before and during the growth season inevitably strengthen the water stress by accelerating water consumption in the soil and trees through evaporation and transpiration, resulting in the formation of narrow rings, and vice versa. Reasonably, positive correlation of tree rings with monthly precipitation and negative correlations with monthly mean temperature in current growth year was identified in this study, and this climate-growth pattern was generally reported in the arid to semi-arid CLP (Gao et al., 2005; Liu et al., 2005; Cai and Liu, 2013) and other areas of northern China (Liang et al., 2007).

In the present work, monthly mean temperature from March to August exerts more important influences upon tree growth than monthly precipitation (Fig. 4), which is similar to studies in the Kongtong Mountain (Fang et al., 2012), Guiqing Mountian (Fang et al., 2010a) and the Ortindag Sand Land (Liang et al., 2007), showing the temperature-induced water stress was likely the key factor limiting tree growth. The correlation analysis between PDSI and tree-ring chronology further tested the above hypothesis. Significant correlation is identified from March to August, especially significant in May and June when the temperature is comparatively high and precipitation is very low (Fig. 2), indicating an intensified drought stress.

Anonymous Referee #3

This paper presents an interesting reconstruction of PDSI in the southeast part of the Chinese Loess Plateau for the period 1703-2008. Based on 54 trees (108 cores) analyzed with standard dendrochronological techniques (standardization with a negative exponential curve and linear regression model), it is generally well-written. I recommend its publication after a few minor revisions listed below.

Comment 1. 2.1. Study area and climate, Fig 1. The authors should have mapped the existing tree-ring network or tree-ring reconstructions in the region. These information would help the reader to understand that their reconstruction really fills a gap in this region.

Answer: We have showed the locations of the existing tree-ring reconstructions as black stars (★) in the small map of China on the top left corner of original Fig. 1. In the revised version, we improved Fig.1 and made them easier to see.

Comment 2.

1) 2.2. Tree-ring data. Informations about the position of the tree line in the Lingkong Moutain area would be helpful to know whether the pine trees have been cored at the upper part of their area of distribution. 2) I am also surprised by the reduced number of tree in populations from sites 2 (10 trees) and 3 (4 trees). The authors should explain why they have chosen to include these trees in the final reconstruction. 3) In this section, I think that information about the Mean Segment Length (average number of rings per core) should be added as this parameter has an influence on the maximum wavelength of recoverable information by a resulting chronology.

Answer: 1) Unfortunately, there isn't significant tree line in the Lingkong Mountain area for the highest peak of this mountain is 1953 m. The altitude of Lingkong Mountain generally ranges from 1600 m to 1850 m. Our tree-ring samples were collected at 1480–1700, 1450–1650 and 1450 m, respectively, it's easy to see these locations belong to the low-middle part of the mountain. In the mountainous area of arid to semi-arid northern China, trees at the low altitude usually were limited by the moisture conditions combined by precipitation and temperature (Gou et al., 2005; Peng et al., 2008; Cai and Liu, 2013).

2) I think it's a misunderstanding. We have clearly described that the sample numbers from site 2 were 40 cores from 20 trees (**not 10 trees**), and from site 3 were 8 cores from 4 trees (trees older than one hundred years are very difficult to find), as showed in line 11-15 of page 6316 in the original paper. We included totally 88 cores to produce a regional tree-ring chronology, then for final reconstruction.

Usually, 40 tree-ring cores form 20 trees in a specific site have met the criterion of sample request of International Tree-Ring Data Bank.

3) The mean segment length is 180.5 year, we added it in the revised manuscript.

Comment 3. 2.4.. Statistical analysis. The authors have computed the Coefficient of Efficiency (RE=0.437) to evaluate the model skill. Would it be possible to provide the coefficient of efficiency (CE) (Comparison the estimated data for the veriïnˇA¸cation period to the mean of this period)? Table 1 is very short. It should be removed and added into the manuscript.

Answer: We deleted Table 1. As answers to the 6th question of Reviewer# 1, we gave up the leave-one-out test, and did the split calibration-verification test (Meko and Graybill, 1995), RE and CE were correspondingly presented in the manuscript as follows:

The fidelity of the reconstruction was verified by comparison with the Dai-PDSI data and checked by the split calibration–verification method (Meko and Graybill, 1995).

Result of the split period calibration-verification test showed that the regression model is stable over time. The explained variance (R^2) for the verification period 1983-2005 was 52.1%, and reduction of error (*RE*) and coefficient of efficiency (*CE*) were 0.603 and 0.375, respectively, when the data during 1954-1982 was used to establish the regression model. R^2, *RE* and *CE* were 32.3%, 0.411 and 0.113, respectively for the verification period 1954-1973, when data during 1974-2005 was chosen as calibration. *RE* and *CE*, the two rigorous verification statistics during verification periods showed positive values, indicating sufficient similarity exists between the reconstruction and Dai-PDSI data (Cook et al., 1999).

Comment 4. 1) 4.1. Annual, inter-annual and centennial variation of the PDSI. Amongst the 10 wettest years listed in the first paragraph of this section, 4 occurred between 1946 and 1950. Was this period really wet in the area or does this result from remanance (persistence) effects in the tree-ring chronologies? 2) How did you compute the accumulated anomalies of PDSI ?

Answer: 1) Yes, we can't exclude the possibility of remanance effects in the tree-ring chronologies since the explained variance of our reconstruction was only 46.4%. We checked the Dai-PDSI record of 1946-1950, the 4 wet years disclosed in our reconstruction were not extremely wet in the Dai-PDSI record. However, Dai-PDSI records before 1950 were calculated by interpolation from data of surrounding meteorological stations (with longer records) for the local records only started from the early 1950s. We also can't say that the Dai-PDSI records before 1950 was absolutely accurate. To solve this problem, we added a sentence "**we should point out that low-frequency variation of the reconstructed PDSI was more reliable than high-frequency variation**."

2) The accumulative anomalies of the PDSI (AC), achieved by calculating the cumulative departure from the arithmetic mean for the period of reconstruction (Wei, 2007), can intuitively and effectively evaluate the long-term trend of dryness and wetness (Tian et al., 2007). The long-term trends of decreasing and increasing movement of AC indicate the persistently dry or wet conditions. We supplemented this in the revised manuscript.

Comment 5. 4.2 Temporal and Spatial representation of the PDSI reconstruction. Could you provide the distance between Lingkong Moutain and (i) the Ortindag Sand Land and the Kongtong Mountains?

Answer: The distance from the Lingkong Mountain to the Ortindag Sand Land is about 840 km, to the Guancen Mountain is about 260 km, to the Taihang Mountain is about 200 km, to the Kongtong Mountain is about 530 km. We added these data in the revised manuscript.

Comment 6. Fig.4b. I am really surprised by the persistent positive correlation between PDSI and tree-series especially for previous years as very low correlations are observed with both temperature and precipitations. Could you comment on these differences?

Answer: We explained it as follows. In order to answer this question, as well as the 2nd question of Reviewer#1 and the 7th question of Reviewer#2, we added a new chapter in the revised manuscript as "**4.1 Climate-growth relationship**", Please see the corresponding part in the new version.

4.1 Climate-growth relationship

Lingkong Mountain belongs to the semi-arid area where annual evaporation is more than twice of annual precipitation. High precipitation during the growth season actually benefits the radial growth of tree by providing necessary water for the radial cell division and elongation, while low precipitation limited the radial growth. Inversely, increased temperature before and during the growth season inevitably strengthen the water stress by accelerating water consumption in the soil and trees through evaporation and transpiration, resulting in the formation of narrow rings, and vice versa. Reasonably, positive correlation of tree rings with monthly precipitation and negative correlations with monthly mean temperature in current growth year was identified in this study, and this climate-growth pattern was generally reported in the arid to semi-arid CLP (Gao et al., 2005; Liu et al., 2005; Cai and Liu, 2013) and other areas of northern China (Liang et al., 2007).

In the present work, monthly mean temperature from March to August exerts more important influences upon tree growth than monthly precipitation (Fig. 4), which is similar to studies in the Kongtong Mountain (Fang et al., 2012), Guiqing Mountian (Fang et al., 2010a) and the Ortindag Sand Land (Liang et al., 2007), showing the temperature-induced water stress was likely the key factor limiting tree growth. The correlation analysis between PDSI and tree-ring chronology further tested the above hypothesis. Significant correlation is identified from March to August, especially significant in May and June when the temperature is comparatively high and precipitation is very low (Fig. 2), indicating an intensified drought stress. **PDSI is a measurement of dryness which was calculated based on a water balance equation, depending on not only temperature and precipitation, but also other parameters such as evapotranspiration and recharge rates. Thus, it's unsurprised that the monthly PDSI of previous year had significant influence on tree growth due to the well-known lag effect, though climatic factors in previous year (except the precipitation of September) showed weak correlation with tree growth.**

Editor: J. Guiot

Dear authors

You can see that the comments from three reviewers are all positive and that your paper can be accepted after minor revision. They raise several points that you can see in their review text. Among them, I insist particularly on these ones:

- The introduction should end with the scientific question you want to answer in the paper: you present the methodology that you want to develop but nothing is told about the climatic aspects of your results.

Answer: We have posed two scientific questions at the end of the introduction and answered them in the revised manuscript as follows (Please also see our answers to the 1st question of Reviewer#1):

Questions: Results of this work would be conducive to answer the following two questions: Whether did the drought severity or frequency increase in response to the global warming? Whether the drought condition nowadays in Lingkong Mountain is unprecedented during the last three centuries?

Answers: It's visible that the severity and duration of dry or wet events seemingly strengthened after 1800 AD compared with the earlier stages, possibly due to the impact of global warming. Even so, the recent drought in 1993-2008 was still within the historical framework.

- In the same idea, when you compare IAPO and PDSI, you should go in deeper explanation about the underlined mechanisms.

Answer: We added such explanation to better understand the relationship between I_{APO} and PDSI in the revised manuscript as follows (Please also see the answer to the 10th question of Reviewer #1):

Theoretically, on the decadal scale rather than the annual scale, when I_{APO} was in stronger stages, the thermal contrast between eastern Asia and the North Pacific was strengthened because the low-pressure system of lower-troposphere over eastern Asia strengthens, and the western Pacific subtropical high strengthens with its location shifting northwards (Zhao et al., 2007, 2008). Therefore, lower-troposphere of the East Asian region was dominated by stronger southwesterly winds, in other words, stronger EASM, resulting in more rainfall and wet condition in North China, and vice versa.

- Your dendrochonological methodology (used to construct the final chronology) is not explained in enough details for a more general public (CP is not a disciplinary journal for dendrochonologists)

Answer: Ok, we tried to make it more understandable to the general public in the revised manuscript as follows:

The tree-ring width chronology was developed using the ARSTAN program (Cook, 1985). To retain as much long-term climate variance as possible, negative exponential curve or straight line with negative slope was applied to each tree-ring measurement series to remove the non-climate trends related to tree age or the effects of stand dynamics. We divided the raw data of each ring width by the corresponding year's value of the fitted curve to give a dimensionless index. Finally, all individual indices were combined to produce a standard STD chronology by means of "biweight robust mean".

- A question raised by two reviewers is why there is a so important reduction in the number of cores finally used? Is there is confusion between cores and trees? Are they representative of the complete set?

Answer: Actually, the 3rd question of Reviewer#1 and the 2nd question of Reviewer#3 are different (Please see their questions and our answers). We have clearly described that the sample numbers from **site 2** were **40** cores from **20** trees (**not 10 trees**), and from site 3 were 8 cores from 4 trees (because **trees older than 100 yr are very difficult to find**), as showed in line 11-15 of page 6316 in the original paper. In this work, 108 cores form 54 trees were collected, and we successfully included 88 (**enough to be representative**) to produce a regional tree-ring chronology, then for final reconstruction. The other 20 cores were discarded because of short ages or that were abnormal in comparison with the majority of series.

- More explanation is needed to make better understandable the behaviour of PDSI, as well in relation with temperature, precipitation than on the fact that this variable is highly persistent (see the comments of rev#2 and rev#3)

Answer: We supplemented a new section in the fourth part of "Discussion" as "4.1 Climate-growth relationship", answering this question and the relevant questions of the reviewers. Please see the following part as well as the corresponding content in the revised manuscript.

4.1 Climate-growth relationship

Lingkong Mountain belongs to the semi-arid area where annual evaporation is more than twice of annual precipitation. High precipitation during the growth season actually benefits the radial growth of tree by providing necessary water for the radial cell division and elongation, while low precipitation limited the radial growth. Inversely, increased temperature before and during the growth season inevitably strengthen the water stress by accelerating water consumption in the soil and trees through evaporation and transpiration, resulting in the formation of narrow rings, and vice versa. Reasonably, positive correlation of tree rings with monthly precipitation and negative correlations with monthly mean temperature in current growth year was identified in this study, and this climate-growth pattern was generally reported in the arid to semi-arid CLP (Gao et al., 2005; Liu et al., 2005; Cai and Liu, 2013) and other areas of northern China (Liang et al., 2007).

In the present work, monthly mean temperature from March to August exerts more important influences upon tree growth than monthly precipitation (Fig. 4), which is similar to studies in the Kongtong Mountain (Fang et al., 2012), Guiqing Mountian (Fang et al., 2010a) and the Ortindag Sand Land (Liang et al., 2007), showing the temperature-induced water stress was likely the key factor limiting tree growth. The correlation analysis between PDSI and tree-ring chronology further tested the above hypothesis. Significant correlation is identified from March to August, especially significant in May and June when the temperature is comparatively high and precipitation is very low (Fig. 2), indicating an intensified drought stress. PDSI is a measurement of dryness which was calculated based on a water balance equation, depending on not only temperature and precipitation, but also other parameters such as evapotranspiration and recharge rates. Thus, it's unsurprised that the monthly PDSI of previous year had significant influence on tree growth due to the well-known lag effect, though climatic factors in previous year (except the precipitation of September) showed weak correlation with tree growth.

Interestingly, the period of limiting months coincided with the results of cambial activity of trees in northern China. Tree-ring anatomical analysis disclosed that the radial wood formation of Chinese pine usually started at the end of April (Zhang et al., 1982), and fast growth usually happened from May to August (Zhang et al., 1982; Liang et al., 2009). Similar finding was reported from *Larixprincipis-rupprechtii*, a different coniferous species from Liupan Mountain, north-central China (Guan et al., 2007). Location of our studied sites is far south than the above reported sites, and it's warmer and wetter, therefore, it's possible that the radial growth of tree in Lingkong Mountain may start earlier.

- I do not think that there is so precise peaks in your spectrum. First they are not extremely significant, second you have not a sufficient resolution to distinguish between 2.5 and 2.7, between 3 and 3.2, 7.6 and 7.8, third it is clear that the 102 yr cycle is not reliable because of the low number of years. Then be more cautious in interpreting it.

Answer: Yes, we agree the suggestion that we should be more cautious in interpreting the cycles detected by the MTM analysis.

In Fig. 10, significant 2.0–2.1, 2.5, 2.6, 2.7, 3.0–3.1, 3.5, 3.9 and 7.6–7.8 yr cycles were revealed by the Multi-taper spectral analysis. All these cycles were at 95% confidence level, and the 2.6, 3.0–3.1, 102 yr cycles were at 99% confidence level. We agreed with the suggestion and replaced the short cycles with 2-7 yr cycles; In the original text we also pointed out that the 102 yr cycle may not be reliable considering the limited length of our reconstruction (306 years). We presented this cycle in the text just want to hint that there may exists possible relationship between the solar activity and local moisture condition. To support this hypothesis, the sunspot time series from 1700 to 2009 were derived from National Geophysical Data Center (http://www.ngdc.noaa.gov/) to compare with our PDSI reconstruction (Fig. 9b). The high correlation coefficient between the PDSI reconstruction and sunspot numbers convincingly supported the influence of solar activity on moisture variations in the Lingkong Mountain area.

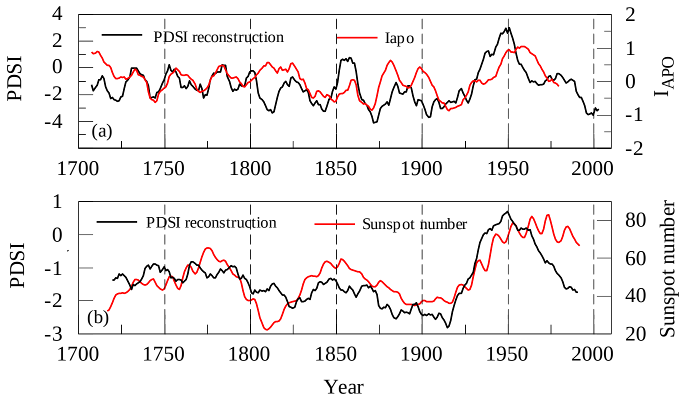

Fig. 9 (a) Comparisons (a) between the 11 yr moving average of the PDSI reconstruction and the summer I_{APO} (Zhou et al., 2009) and (b) between the 35 yr moving average of the PDSI reconstruction and the sunspot number time series.

- You should merge table 1 and table 2; in the caption of the tables, you need to be more explicit (what is r, R2, F etc...).

Answer: We deleted Table 1. As suggested by Reviewer#1, we take split calibration-verification method instead of leave-one-out method, and explain the result in the text. Moreover, we explained the meaning of r, R^2, R^2_{adj}, F and P below Table 1 (actually Table 2 in the original manuscript).

Please submit a revised version with a cover letter where you explain the change you have done in the revised version. Provide also a reply to the comments of the three reviewers.

Best regards

Joel Guiot

Supplemented references:

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