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Climate of the Past Discussions

Interactive comment on "Precipitation variations of Longxi, northeast margin of Tibetan plateau since AD 960 and its relationship with solar activity" *by* L. Tan et al.

L. Tan et al.

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The reviewers give constructive suggestions and interesting discussions to the manuscript, we address them as follows:

Anonymous Referee 3 comment

"The presentation is clear, but the English is poor and strongly needs improvement by a native speaker (which I am not)"

I am sorry, the English of the manuscript has been further improved in the revised paper.

"The authors compare their paleoclimate data with the atmospheric 14C record as a reflection of solar activity. However, delta 14C contains a system component which perturbs the solar signal to some extent. System effects are caused by the large 14C reservoirs (the ocean, atmosphere, biosphere) and the exchange between them. Therefore the 14C production rate would be a better proxy to compare with. See e.g. http://www.cosis.net/abstracts/EGU05/07552/EGU05-J-07552.pdf. It might be useful to contact J. Beer, R. Muscheler or another representative of the cosmogenic isotope community to get such production data."

We agree with you. Muscheler et al. calculated two records of solar modulation function variability over the last millennium based on 14C and 10Be by considering multiple influencing factors, and found there was a good agreement between the two. The agreement suggests that the variations in these isotopes are primarily driven by solar activity, carbon cycle changes do not have significant influences in atmospheric 14C concentration and the averaging of 10Be records both in Northern and Southern Hemispheres can well reflect the globe changes in 10Be production rates (Muscheler et al., 2007). In the revised paper, we compare our precipitation records of Longxi with the atmospheric 14C concentration, the averaged 10Be record, the reconstructed solar modulation record, we find there are also good correlations between precipitation and solar activity. See section 5.2, paragraph 2.

"There is one publication which I would like to advise to include (under 5.3) as a reference as it gives the most impressive paleo-record of solar forcing of climate change in Europe: Magny M. 2004. Holocene climate variability as reflected by mid-European lake-level fluctuations and its probable impact on prehistoric human settlements. Quaternary International 113: 65-79. Based on a high correlation of his lake level record with delta14C, Magny concluded that solar variability was a major driver of climate in

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Central Europe."

Yes, it is another important evidence for the solar-earth climate relationship, we have added this reference in the revised paper.

Anonymous Referee 2 comment

"(1) If possible, I expect to read the comparison between several extreme drought/flooding events of the study area and other regional records. This may be helpful to verify exactness of the reconstructed precipitation record."

We tried to compare the big drought events in MingQing Dynasty of Longxi with other records in northern China, but the scarcity of high resolution precipitation records there block the further comparison. However, we do some in the revised paper, see section 2.2.

"(2) A detailed figure of the study area should be added and zoomed in."

It has been added as Fig. 1b in the revised paper.

"(3) Marking spans of mentioned dynasties in some figures (for example, Fig. 2 and 3) is convenient for readers."

We have modified it in Fig. 2, Fig. 3 and Fig. 4.

"(4) English writing of the article needs to be polished further."

It has been further improved in the revised paper.

J. Fei comment

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"(1) A large number of historical literatures are utilized, and they are of great importance to the subsequent analysis. However, the original literatures and the references are not shown in the paper, thus hampers an evaluation the reliability of the literatures or that of the curve. It would be much better to give a few examples in the text and/or list the full texts as supplementary materials."

We give some examples of historical records in Table 3 in the revised paper and the referred literatures are listed under the bottom of Table 1 and Table 2.

"(2) As far as I know, most of the records in the chronicles are about floods and droughts. Are flood/drought variations equal to precipitation variations?"

The flood defined in this paper is caused by heavy rain, not by weak water conservancy or other factors. As described in section 1, the annual rainfall in semi-arid zone is relatively low and varied greatly. Heavy rain or heavy drought has important influence to annual rainfall in these areas. For example, at Aug. 8, 2007, heavy rain brought 39mm rainfall to Lanzhou just in two hours from 8:00 to 10:00 am. At Aug. 7, 1978, heavy rain brought 96.8mm rainfall to Lanzhou in one day (http://news.huash.com/2007-08/09/content-6476101.htm). However, the total amount of rainfall in Lanzhou in 1980 was just 189mm. We think if there were records of heavy rain lasted for a long time, it can indicate the increase of annual precipitation, and if there were records of big drought lasted for a long time in raining season, it can indicate the decrease of annual precipitation. Although the flood/drought variations do not exactly equal to precipitation variations, it can reflect precipitation variations.

"(3) There are too many gaps in the historical data, particularly in the first half of the time series (circa. AD 960-1400). The reliability of the curve might be graded into two epochs: relatively good from AD 1400-present, and relatively poor from AD 960-1400."

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Yes, we do not have climate records in every year. This may be ascribed to two reasons, one is the fitting climate that no flood/drought occurred in the year. This was a principle of Chinese historical climate recording called "record changed climate and do not record constant climate"(Gong et al., 1983). The other one is the missing of climate records. There were less climate records in AD 960-1400, which hampers us to study the precipitation variations of Longxi area on decadal scale. Nevertheless, on multi-decadal to centennial scales, we think it can reflect the precipitation variations during this time.

"(4) The reliability of the historical literatures is assessed to be good (Section 4.1). However, the assessment process is not persuasive. The authors argue that many of the local chronicles cited in this paper were written in early time. Several ancient chronicles are selected as examples, but the authors do not state objectively that most of local chronicles were compiled no earlier than the 17th century."

In this paragraph, we just discuss the reliability of climate records in local chronicles, so documents described here are all local chronicles. We mainly extract climate records from local chronicles in Ming and Qing time (AD 1368-1911). Although most of the local chronicles were compiled no earlier than 17th century, they can record much information of climate change during MingQing time, and many of the documents they inferred maybe not reserved to today. So, local chronicles are very important in local climate studying, especially in the last 500 years. Climate records in Northern Song, Jin and Mongolia Yuan Dynasty mainly come from Song Shi(History of Song Dynasty)(completed at AD 1345), Jin Shi(History of Jin)(completed at AD 1344) and Yuan Shi(History of Yuan)(completed at AD 1370).

"(5) The authors suggest that the solar forcing is the main driving force of the precipitation variations of Longxi during the last millennium (Sections 5.2 and 5.3). Do the

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curves of precipitation variation (if it is reliable) and solar irradiance really correlate well(Fig. 6)? The driving force of precipitation variations of the past millennium should be complicated. What about volcanic eruptions, greenhouse effects, ENSO and other potential forces?"

We suggest that solar activity may be the main driving force of precipitation variations of Longxi area on multi-decadal to centennial scales in the last millennium in the manuscript, but do not exclude other factors' impact. Although the precipitation record and solar activity record are not exactly corresponding with each other in phases and details, they correlated with each other on multi-decadal to centennial scales, if considering the different resolution between the two series. However, climate system is complicate, and the external solar influence will be magnified by internal feedbacks of earth system such as ENSO. Emile-Geay et al. (2007) proposed that ENSO might have acted as a mediator between the sun and the earth's climate. Volcanic and greenhouse gas main influence the earth's temperature, although they may have some influences on precipitation by affecting ocean SST, and the volcanic eruption is mostly related to abrupt cooling event of several years long (Briffa et al., 1998; Strothers, 1999; Zielinski, 2000; Fei et al., 2007) .
In this study, we just simply focus on the role of solar activity and think solar activity maybe an important driving force of precipitation variations of Longxi area on multi-decadal to centennial scales in the last millennium. In the revised paper, we give some explanation. See section 5.2, paragraph 2.

"(6) The schematic map (Fig. 1) shows the location of the study area, but it does not identify the area clearly, and it would be much better to produce a map with a bigger scale and clearly illustrates the area."

It has been added as Fig. 1b in the revised paper.

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Interactive comment on Clim. Past Discuss., 3, 1037, 2007.