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Climate of the Past Discussions

Interactive comment on "How could phenological records from the Chinese poems of the Tang and Song Dynasties (618–1260 AD) be reliable evidence of past climate changes?" *by* Yachen Liu et al.

Anonymous Referee #3

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Review to the paper:

How could phenological records from the Chinese poems of the Tang and Song Dynasties (618-1260 AD) be reliable evidence of past climate changes?

Yachen Liu et al.

The paper raises the attention to an interesting and unique source of phenological information, early and high-medieval Chinese poems, and provides a preliminary analysis and temperature reconstruction referring to selected areas. It is well visible that

the authors invested much time and energy into this paper, the source is really unique and worth for further investigations. It is important to stress that I do appreciate many parts of the paper even if I do not mention them. However, in the review I rather try to point on the problems where in my opinion improvements are necessary. There are some basic methodological problems in the paper that has to be solved prior to publication: without a substantial improvement of the methodology, the paper is not suitable for publication in Climate of the Past. Therefore, I suggest major revision, and I would like to see and evaluate the next version of the manuscript.

Historical background and interpretation

The uncertainties are discussed in a rather detailed and informative way, and the authors also state that they only apply poems when the poets are contemporary – this is a very important and valuable information, what should be in my opinion emphasised also earlier (maybe already in the abstract?). Does this mean that the (contemporary) poets are known in all cases? And what cases are we talking about? Are these the poems where the 86 phenological data are coming from, or do the authors have a broader-scale overview, so that they are able to provide a general picture for a larger region than the study area (and if yes, based on how many poems/data)?

Just a side remark on the uncertainties subchapters: some of these uncertainties could be explained shorter and more accurately, once the authors involve a (Chinese) medieval social, economic or environmental historian as co-author of their study.

The authors discuss an over 600-year period covering the early and high-medieval period. Providing basic socio-economic background on how and why these poems were written (with reference), and the basic environmental characteristics (differences compared to recent times) of the environment the poets lived in and described should be an essential part of the presentation and analysis. As the topic is particularly sensitive on source dating, reliability and contemporary social/environmental background, the active participation of a trained (Chinese) medievalist, who can give a short concise

historical overview, would be in my opinion essential.

Geographical coverage

Even if it is clear that the authors would like to present the potentials of Chinese poems, and these potentials are valid for entire China, based on the information presented in line 305 and on their previous paper(s) in the subject, they have tested source potentials only in one area of one province. There is no problem with that but, please, do indicate this information at the beginning of the paper (i.e. you should have a "Study area" chapter at the beginning, which is a usual part of papers in CP), too. Because it is a rather important information that the authors do discuss this topic based on a database regarding entire China, but only one area within a province, and in fact you suggest that this might have relevance for the entire China. China is huge, and even in your study period there were long periods when China was not one empire, but an area divided to separate states. So, it would be also useful to discuss shortly why you think that in this rather eventful period of China's history this source was written in the same way and out of the same reasons when historical background (and also the level of literacy) in faraway regions could be rather different. Again, a (Chinese) medievalist would be able to answer this latter question easily and adequately.

Interpretation of past phenological information

The authors present both biological and physical phenological information. The biological information consists of plant and animal related phenological data. At first, I really needed to search a lot to figure out how many and what (wild) animal-related phenological data the authors actually used in the (case) study, and then I realised this was one bird type. It would be useful to state such information, because based on the main text (about source potentials of entire China and the entire study period) one expects several different types of animals. As for the plant-related phenological information, the authors mention different types: ornamental and cultivated plants.

What do you mean under "ornamental plant"? The only case where I saw any expla-

nation was Table 1, where an example was added: "Plum blossoms begin to bloom in early winter". But plum is a fruit tree and as such, it is part of the cultivated vegetation, and fruit production is usually part of the agriculture. Why is it considered separately? Similarly, "ornamental animal" comes at one point in the picture, but it is not clear what it means and why it is mentioned.

I have some problems with the presentation of phenological information related to cultivated plants, as it seems the authors treat them as if they were similar modern cultivated plants. There is no any indication in the paper that early and high-medieval agriculture used rather different grain and other cultivated plant types/varieties (even plum or almond trees) than modern agriculture, not talking about the fact that medieval agriculture was on a totally different level than its modern equivalent. Although these differences usually have an effect on a temperature reconstruction, there is no any indication in the paper that the authors would have taken these differences into consideration. Again, the related knowledge of a Chinese historian expert would have basic importance. To some extent, the same is true for some of the physical indicators, particularly for the development of river ice (e.g. differences in streamflow due to river regulations, dams can strongly affect temperature-river ice relationship).

Moreover, it is not clear exactly what phenological phenomena the authors relate to what temperatures (i.e. what periods of the year), because the authors simply refer to Chinese Meteorological Administration, and do not give any further information. It would be useful to conclude shortly the information taken from these official records. I also have problem with using only 30 years (1961-1990) to identify the exact relationship between temperature (of what period?) and phenophase information. Phenology-based temperature reconstruction studies usually consider 50-60 years, at least, to identify this relationship. I understand that it is not possible to have longer overlap in some cases, but at least in those cases when it is possible to extend this control period, it would be useful to do it, and try out whether a longer control period gives the same relationship as 30 years.

Validation of results and Statistics

In the abstract, the authors refer to the abundance of the source (poems) and phenology information, but this abundance does not reflect on the applied database and the correlation statistics, where only 86 phenological data are available, covering only 38 years out of 300 years with any temperature-related information. Moreover, according to Appendix C, correlation statistics is based on a database where more than 2/3 of the phenological data types are calculated with the number of observations under 30, and 1/3 is under 20 – thus, in most cases the number of observations in fact does not reach the value to have any statistical significance. Moreover, sometimes even with the low observation number, correlations are rather low. In these cases, it would be useful to provide more information on why the authors think these data have further potentials. While in line 303 the authors suggest that they have selected 86 phenological records for validation, in line 382 the number of records is 85. So, is it 85 or 86? Either 85 or 86, this sounds like a rather low number for a reconstruction. Especially if we consider the fact that the authors used a number of different phenological data. I find the temperature reconstruction methodology a bit problematic. Based on Appendix B, in the reconstruction the authors applied the simple method of linear regression. However, in case of non-continuous datasets, as it is clearly the case with poem-based phenological information, the method of linear regression is not really a good method to apply. Could you explain why you think linear regression is the most suitable method to apply in this particular case? In fact (as I mentioned before), I also do not particularly like the fact that the authors treat this rather mixed set of early medieval phenological data automatically similar to those of the late 20th century.

I have read several times the validation subchapter and the related Appendix parts, but I still do not fully understand how the authors were able to reconstruct annual temperature anomalies. Do I understand well that – based on Fig. 3a, the Validation subchapter and the Appendices – the authors reconstructed annual temperature anomalies of over 300 years in a study area, based on 85 or 86 phenological data (if I understood well,

covering only 38 years)? How? This sounds far too little evidence for any temperature anomaly reconstruction. Such a temperature reconstruction would require that the database (near-)systematically cover the study period or at least a significantly higher number of observations. So, here a bit more explanation would be needed why the authors think 38 years of data can adequately describe the weather anomalies of 300 years.

In the Validation subchapter and in Fig. 3(b) the authors referred to another paper (Liu et al. 2016): this paper contains an annual temperature anomaly reconstruction for the period 600-902, in the Guanzhong Area – practically the same study area and period the current paper discusses. In Liu et al. 2016, the temperature reconstruction was based on 271 (phenological, weather and climate, and human response) data, from which 87 was phenological data. As we received little information on the exact 86 (or 85) phenological data the current study utilizes, the question arises whether or not there is an overlap of phenological data between the database of the current study and the phenology data part of the Liu et al. 2016 database. Especially, because the only phenological source quotation Liu et al. (2016) provides as an example is quoted from a poem. It is also not clear for me how and why this temperature reconstruction – or even the comparison with the Liu et al. 2016 paper – provides any validation for the utilisation potentials of poem-based phenological data. The authors used modern phenology-measured temperature relationship, applying it on early-medieval poem-based phenological data, to reconstruct early medieval annual temperature anomalies. As for the validation, as described above, it is not clear whether or not the Liu et al. (2016) reconstruction is independent from the current reconstruction. If not, the Liu et al. 2016 reconstruction should be applied with caution. Second: while comparing the two reconstructions in Fig. 3, the authors suggest that "There were approximately simultaneous temperature fluctuations between the two reconstructions,. . ." – well, looking at the Figure, this "simultaneous fluctuations" are not so easily and obviously recognisable. A statistically significant correlation would be a stronger proof for simultaneous fluctuation, but the authors do not provide any information on that. Dear

authors, please, give correlation data.

Accounting with so low data density and so many uncertainties, to me it seems somewhat surprising to state that annual temperatures were "0.43°C and 0.29°C higher during the study period (600-902 AD) than at present (1961-1990)." I doubt one can give such exact statements (without an estimation of uncertainties), when temperature related information is available only for 76 and 38 years out of 300 years. Based on these statements, I assume that the years for which information is not available were regarded as "average". However, if there is no poem referring to any phenophasis dates for 2-3 (or more) years in a row, this does not mean there could be no negative or positive temperature anomalies or even extremes in these years. It means only that no poem dealt with this question. In this respect, it would be useful to know how many different authors these 86 phenological data come from.

The authors do not compare their reconstruction to any other reconstructions from China. Is it because there are no other annually-resolved temperature reconstructions available in (Central-)China that cover the period 600-900? Because if there is at least one other, independent reconstruction (documentary based or natural scientific), then it would be useful to compare (and correlate) the current reconstruction results to that reconstruction (or reconstructions, if more than one exists).

And finally an addition: poems and songs are also applied in historical climatology in Europe, but it is not used independently for reconstruction, and poems very rarely contain phenological information (but it is not without an example).

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