Climate of the Past Discussions

Clim. Past Discuss., author comment AC1
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Reply on RC1

Chantal Camenisch et al.

Author comment on "A Bayesian approach to historical climatology for the Burgundian Low Countries in the 15th century" by Chantal Camenisch et al., Clim. Past Discuss., https://doi.org/10.5194/cp-2021-169-AC1, 2022

Reply to anonymous referee #1

General comments

The manuscript is an interesting work on climate reconstructions based on historical documents. It is an original approach from a methodological point of view. The Bayesian approach is an interesting methodology, and an original way to integrate the output of climate models (prior state) with historical data (observation/climate conditional probabilities). In this sense, it seems very appropriate to be published In "Climates of the Past". However, I have some doubts, questions, and suggestions.

Many thanks for your referee report, which we appreciate very much.

Specific comments

- Although the authors include some references on documentary data, it is desirable a more complete and detailed description of data sources (authors, motivations, spatio-temporal coverage, density of information, etc.). Please, include in Figure 1 the cities and/or locations with historical information.

Many thanks for this comment. The original data set is already described and published in a paper in Climate of the Past and in a monograph (Camenisch 2015a, 2015b) to which we give reference. There is also a map with the places, where the sources derive from. But of course, we add more information on the sources to the paper and the major places to map.

- According to the authors, the reconstruction method is strictly applicable using variables following Gaussian distributions. In fact, Pfister indices use implicitly this hypothesis assuming the symmetry around the 0 value. This may be true in the case of temperatures, but I have doubts on precipitations, where it may be not appropriate to define symmetrical indices (from -3 to +3), due to the non-gaussian character of rainfalls.

This is correct. Our method is only applicable to variables that follow a Gaussian distribution such as temperature. This would advise against using our method to reconstruct precipitation due to the non-gaussian nature of rainfalls. To tackle this issue,

we did not reconstruct the usual precipitation rate, but a Gaussian-distributed custom variable (wetdaysinmonth) defined as the number of days in a month with more than 1 mm precipitation within a model day (lines 104-106 of the manuscript). This prevented us from reconstructing any non-gaussian variable, keeping the study free from inconsistencies. We will clarify this point in the revised version of the manuscript.

- Tables 2 and 3. The assignment of likelihoods to Pfister indices is arbitrary. In the case of Table 2, why 25 to index +1, and 0.30 to index +2, and not the opposite, 0.30 to index +1 and 0.25 to index +2? Indices methodology tries to convert qualitative descriptions into numerical values, and, certainly, some degree of subjectivity is always present. I recognize the effort of this approach to reduce this ambiguity, but this example do not diminish my doubts about this problem.

Many thanks for this comment. Table 2 shows an example of a well-documented summer, whose descriptions are similarly – but not identically -- likely assuming either a +2 (very warm) and +1 (warm). Although +1 seasons are a priori more probable than +2 seasons, that is not our concern in this step of the reconstruction. In this step of the reconstruction, we are assessing which hypothetical climate state would have been more likely to produce the present evidence. In this case, it is slightly less likely that a hypothetical +1 summer rather than a +2 summer would have produced these descriptions, since summers that were fairly normal (only +1) tended to result in less description of warm conditions. Nevertheless, if the a priori probability of a +1 summer is much higher than a +2 summer, then the posterior probability distribution will reflect this.

In the original index, such a case would appear simply as +2 with no possibility to express these uncertainties about the evidence or prior probabilities. Thus, even though both the index method and the Bayesian approach rely on expert judgement, we believe the latter is less arbitrary.

This is just one example. The entire reconstruction is based on the 450-page PhD thesis Camenisch 2015a, where each year is examined individually. We propose to change the caption to "well documented summer with a similar distribution of likelihoods for +2 (very warm) and +1 (warm)" to make it clearer. We will add to the text that "well-documented" means there are several descriptions of the weather in the historical sources.

The model example in Table 3 is different: In this case, there are no descriptive sources for this summer. Since descriptions are available for very many summers of the 15th century and since many decades have a very good coverage by historical sources as a whole (in the same year, the summer may not be described, but maybe the spring and the autumn are), it is practically impossible that extreme events would not have left any traces. So, there is maybe no description of the weather in the sources, but of course this is not equivalent to no information about the season. We propose to change the captions to "no description of the weather" instead of "undocumented".

- In relation to Table 3 and the lack of information, the absence of information it is not equivalent to the absence of climate events (extremes) in the past. It depends on the nature of data sources, spatio-temporal coverage and resolution (it is possible to find new data sources that compel to refine the reconstructions). Therefore, it is important not only the description of data sources (Point 1), but also the study of their spatio-temporal coverage, that is, their density of information (distribution of reports according spatial and temporal scales).

This is exactly what we want to say with this hypothetical example. Our knowledge does not only consist of the lack of a description of this one summer. We know much more, of course. For example, we have detailed knowledge of these sources in the Burgundian Low Countries and can therefore make a very good estimate of the data coverage for each

decade or even for each individual year: e.g., whether for the years in question there were one or more reliable chroniclers reporting regularly; whether there where important political events that could have suppressed weather reports; and where there are indicators such as grain prices show for the region and season. I suspect that the referee was bothered by the term "undocumented" in the caption. So I suggest that we adjust this caption here and go more into detail in the text about what exactly we mean by this example.

- How do you calibrate and/or validate your reconstruction? This is the major problem that I see in this manuscript. Criteria on uncertainty and/or error bars are unclear for me. A more detailed description on technical aspects of this methodology would be desirable.

Thank you very much for this important comment. In this present reconstruction, the highest probability is in each case on the same index values that were already determined in 2015. So these maximum values are not new. New is the addition of (lower) probabilities each additional index value that was not selected in 2015. The detailed explanations why originally one index value was selected and not another, as well as the criteria for each index value, can be found in Camenisch 2015a. In Camenisch 2015b, the indices were compared with other reconstructions (e.g., Litzenburger 2015) and examined for correlations. These methodological approach was 2015 accepted in the peer review process of this journal. In the revised version we explain this more clearly.

For this region and period (15th century), there are no historical climatology index series that overlap with instrumental records to enable a calibration-verification procedure. Camenisch 2015a and 2015b created an index series that was accepted based on established methodology, comparison with series for neighboring regions, and comparison to reconstructions based on paleoclimate proxies.

Our method builds on the research in Camenisch 2015a and 2015b. It incorporates all the evidence and knowledge utilized in that reconstruction. However, it removes implicit judgments concerning prior probabilities that are built into the traditional index method and makes explicit those judgments regarding likelihoods that are also built into the index method. Therefore, it should be more reliable and less arbitrary than the traditional index method.

Moreover, our method incorporates all available information into a single posterior probability distribution for the target variables. Previously, scholars may have examined reconstructions from paleoclimate reconstructions or climate field reconstructions that integrated climate forcings and paleoclimate proxies alongside historical climatology reconstructions. They may then have made their own informal inferences regarding the most probable true values – a kind of fuzzy Bayesianism. We formally employs Bayes' theorem, integrating all information to obtain single series of posterior probability distributions.

Because our method already integrates all available information, and because there is no overlapping instrumental record, the resulting posterior probability distributions cannot be compared to any other independent measure or reconstruction. Therefore, we cannot demonstrate its reconstruction skill. Instead, this study demonstrates: (1) that the method is feasible and can fully integrate information from climate modeling and assessment of historical records; (2) that historical knowledge can be modeled as a process of Bayesian abductive inference; and (3) that the weather and climate information in historical records -- expressed as a ratio of likelihoods $p(e|h)/p(e)$ -- can bring convergence to divergent paleoclimate model outputs.

We propose to revise the introduction to clarify the scope of the article. We will propose

further studies in periods overlapping with the instrumental record in order to test the skill of the Bayesian reconstruction method and compare it to the traditional index method.

- Finally, I miss an adequate comparison with other reconstructions. In particular, to obtain a clear view of the convenience of this approach, it would be interesting a comparison with the simple reconstruction based on Pfister indices. In addition, it would desirable to find reconstructions from other proxy data (in particular tree rings), to validate your reconstruction, or, at least, to compare your results with those from other proxy data.

See answer 5 above.