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Comment on cp-2021-169

Anonymous Referee #2

Referee 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-RC2, 2022

In their manuscript, Camenisch et al. present a new approach to quantitative reconstruction of temperature and precipitation characteristics from documentary sources. Through Bayesian inference, categorical data derived from historical archives are assimilated into GCM-generated ensembles of climate simulations, effectively combining temporal variability of both these sources. Application of the technique is demonstrated for seasonal temperatures and numbers of days with precipitation in the Low Countries (NW Europe), over the 1420-1499 CE period.

The paper is competently written and topically well suited for the 'International methods and comparisons in climate reconstruction and impacts from archives of societies' special issue of the 'Climate of the Past' journal. I only have a few comments/suggestions regarding the methodology, results, and their presentation (I leave it at authors' discretion whether and how they will consider them in preparation of the final manuscript):

(C1) Extensive ensembles of GCM simulations were used to generate the base (prior) probability distributions. However, since the year-to-year variability in such simulations is largely uncorrelated with historical variability in the climate system, retaining full intra-ensemble variability (as described in Sect 3.3) seems to add unnecessary noise to the prior data. This noise is then partly carried over to the posterior data (this is especially apparent in Fig. S1, visualizing results obtained for the smaller (13-member) CESM-LME ensemble). Perhaps using somewhat less 'noisy' data to generate the prior probability distribution (e.g. by employing mean value of the ensemble instead of its complete spread) would result in less noisy reconstructions, while still retaining the relevant variability from the GCM-simulated series (such as components tied to boundary conditions and external forcings, which are shared by all ensemble members).

(C2) Minimum probability threshold of 0.05 was prescribed when generating the probability distributions (l. 154+). It feels that in some situations, this may act as unnecessary artificial degradation of the signal (e.g., when a distinctly hot summer is indicated by the documentary sources, yet the probabilities for sub-normal temperatures are still set to be greater than zero regardless). Perhaps using a simple formal parametric approximation of the probability function, e.g. by (suitably transformed) binomial or Gaussian distribution, would better capture the related uncertainties (with probability values outside of the most likely categories still being non-zero, but not constrained by an arbitrary constant).

(C3) I wonder about uncertainties/ranges shown for the reconstructions in Figs. 6 & 8 and how they relate to the posterior data visualized in Figs. 4 & 5. For instance, in Fig. 4a (winter temperature), the 1459 CE temperature estimate seems quite uncertain (i.e., the posterior probability distribution is rather widely spread among several categories), whereas much lower uncertainty is indicated for 1460 CE (narrower probability distribution, dominated by a single category). Yet, there is no major difference in the size of the estimated temperature ranges for these years in Fig. 6 (in fact, the ranges seem to be near-identical in size throughout the entire period covered). If these are derived solely from min-max values of the GCM ensemble (as described at l. 233+), perhaps it would be useful to also provide uncertainties derived from the spread of posterior distributions in their entirety (and thus to consider not only uncertainty of the prior (GCM-based) data, but also that from the documentary sources).

(C4) It might be useful to see how well the temperature/precipitation reconstructions match actual weather variability typical for the target region (to see if, e.g., variance of the reconstructions matches the real climate, or if there is under/overestimation). This could be done, for instance, by adding observational distributions for the instrumental period to Figs. 7 and 9 (and discussing which eventual differences stem from comparing two different periods, and which may be related to biases in the reconstruction itself).

Minor/technical comments

- Abstract, l. 9+: '… our reconstructions present a high seasonal temperature correlation of ☐8 independently of the climate model employed to estimate the background state of the atmosphere.' – it is not quite clear from this formulation what the correlation value refers to (i.e., which two signals are being compared)
- l. 188: '… (drier) conditions are associated with positive indices.' – this seems to clash

with definition at l. 131, which associates positive values of the index with wetter conditions

- l. 198: comma instead of dot
- Fig. 9: Maybe it would be useful to add a symbol to each of the four post-volcanic years (instead of just number), so that it is more clear that these are specific data points
- Sect. 2: Perhaps elaborate a bit more on the exact extent of the target region – it might be particularly helpful to show locations pertaining to individual documentary records used, e.g. by including them in Fig. 1