

Interactive comment on “Climate indices in historical climate reconstructions: A global state-of-the-art” by David J. Nash et al.

David J. Nash et al.

d.j.nash@brighton.ac.uk

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Response to Anonymous Reviewer #1 [RC1]

We thank the anonymous reviewer for their time and thought, which will help to improve significantly the overall quality of the manuscript. We respond to each question raised in turn:

[RC1] In the introductory part, three main categories of information are mentioned that appear in historical documents and inscriptions (lines 32–35) and in the following paragraph authors state that the generation of ordinal-scale indices is a common approach for the analysis of the third category – descriptive (or narrative) evidence. However, in the following sections, they mention numerous examples of indexing approach also for

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the two remaining categories – e.g. sea-ice index (Ogilvie, 1996), phenology-related phenomena from China (section 3.5) or even indices derived from early instrumental measurements (Figure 5 or section 6.2, lines 519–520). I would very recommend to provide somewhere in the introductory part at least some explanation why such type of information (quite often already existing at least on the ordinal scale) is transformed to indices. It would be quite useful to add some simple categorization of indices.

[Response] The reviewer makes a good point here. We do indeed include examples where ordinal scale data are converted to indices as part of the reconstruction process, and this is especially true for regions outside Europe or at its margins, where narrative information is less available. Almost invariably this occurs when quantitative data are integrated with information from narrative sources to generate indices. Even where instrumental measurements or quantifiable phenological data exist, it may be desirable to develop ordinal indices so that these quantitative data can be combined with descriptive, qualitative information. In this way, it is possible to develop longer, more continuous and homogenous series with a consistent resolution (monthly or seasonal) and hopefully reconstruct both low-frequency and high-frequency variability. To address this point, we will add additional text to the introduction to explain why this is the case and reiterate this point where appropriate in relevant sections of the manuscript (e.g. in the sections on African and Asian index series).

[RC1] Sections 2–7 provide a detail overview of various index types that different authors compiled at individual continents and ocean according to the meteorological element reconstructed. Too much space is devoted to the scale of index series. At the same time, it is mentioned several times in the text that number of points (or granularity) is dictated above all by the quality and abundance of documentary evidence (e.g. lines 136, 614). In my opinion, more information should be provided on different characteristics of the index series in this part of the text. Those are e.g. the completeness of the index series, their temporal coverage, the way the missing information is handled, meaning of the “zero” category, overlap with the target data for quantitative

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reconstruction and so on. Authors mention such characteristics only sporadically.

[Response] We take the reviewers point here. We will edit the text to reduce descriptions of the scale of index series and remove any repetitive statements about how the quality and abundance of documentary evidence influences the granularity of index series. We will also add information throughout the manuscript on the completeness of index series and their temporal coverage. The comment about how missing information is handled is a particularly important one. There are two main approaches used to define “0 index” values. One – implicit in the Pfister method – is that no description means no number: a gap in the time series rather than a 0. Other studies make an implicit assumption that, in some circumstances, no weather description can be taken as an indication of normal conditions. We will insert additional text about this in Section 8 and include a paragraph in section 9.2 where we discuss confidence and uncertainty in index-based climate reconstructions.

[[RC1] The 3.2 section provides very detailed description of diverse Chinese documentary sources, often not used for index series construction. Moreover, this part is quite long, not directly related to the topic of indices in some cases and it has no corresponding counterpart e.g. for Europe.

[Response] We thought carefully about exactly this point when we were compiling the original manuscript. The nature of documentary sources is well discussed in climate history literature for most parts of the world. However, to our knowledge, there has been no corresponding detail made available for the diverse range of Chinese documentary sources. Hence, even though this text adds to the length of the manuscript, we consider it important for a climate history and historical climatology audience. The same is true for Japanese and early Russian materials, hence the reason we also say more about sources for these regions. We will add an objective to the paper regarding ‘the promotion of studies from regions beyond Europe’ to encourage specialists in these areas to engage in further work on climate index production.

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[RC1] Section 8 on methodological approaches used to derive indices appears the most important for those searching for “good practice for future studies” and for advice how to derive indices from their own data. In this sense, however, at least some approaches mentioned here would deserve a short comment or some sort of critics (Section 8.3, end of the first paragraph: Correlation coefficient is a relative measure and the value of 0.5 means that compared data sources share only 25% of common variability. Statistical significance of the correlation would be much more relevant).

[Response] Thank you for this observation. We will review the text in section 8.3 to ensure that the discussion of index development is sufficiently critical.

[RC1] The same holds for some statements in Section 9. Please check lines 821–829. The whole paragraph is hard to understand and it does not make sense – at least from statistical point of view. It is not clear how “. . . chi-square tests, comparisons with the eigenvectors . . . and the standard error of the estimate” can be used “to derive transfer functions”. For instance, the standard error of the estimate is the result of the transfer function calculation. Thus, it cannot be used to derive it. Similarly: “Such correlations can further be compared and calibrated using instrumental data”. Please re-formulate as correlations (of what?) can be hardly “calibrated”.

[Response] Thank you for this comment. We will review the text in lines 821-829 to improve readability and ensure that it is accurate in its use of statistical terminology.

[RC1] In section 9.2 on confidence and uncertainty there is a discrepancy between the title of this section and the text that follows. “Uncertainties in index-based climate reconstructions” are different from uncertainties related to the index series compilation. Both types of uncertainty are very important, however, they have several different reasons and different origin. Unfortunately, the text provides only some examples of the second type of uncertainty (related to the index series compilation). It would be very useful to mention at least some examples of the first one (Dobrovolny et al., 2010). Ability to quantify uncertainties in the index-based reconstructions (either formally – with

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some statistics or less formally – by comparison with other reconstructions) makes them fully comparable to natural proxy-based quantitative reconstructions.

[Response] Thank you for this very helpful comment. In this section, we are focusing mainly on uncertainties related to index series compilation. We will clarify the text to make sure that this is obvious to the reader, but also mention the suggested example of wider uncertainties in index-based climate reconstruction.

[RC1] It is obvious that this overview cannot refer to all relevant studies. However, I would recommend to mention in the text several other studies especially from Europe. They can be an important example of the indexing approach (Koslowski and Glaser 1999; Dobrovolny et al., 2015), example of multiproxy reconstructions using temperature (Luterbacher et al. 2004) or precipitation indices (Pauling et al. 2006) or papers important from the methodological point of view (Dobrovolny et al. 2009, Brázdil et al. 2016).

[Response] Thank you for these helpful suggestions. We will review each of the recommended papers and add them to the manuscript where appropriate.

[RC1] A suggestion for the Section 10.2, concluding recommendations: Even if the index series are constructed at several-degree scales (7 or more points), indexing always means suppressed variability of index series compared either to target data (instrumental measurements) or to natural proxies (e.g. tree rings). It is advisable to sum-up index series – either in time (from monthly to seasonal or annual) or in space (put together several index series from climatologically homogeneous region). This approach may well approximate index series to natural climate variability.

[Response] Thank you for these helpful suggestions. We will add a bullet point to this effect to the series of recommendations in section 10.2.

Minor comments [RC1] Line 43 – the term "unweighted" index may be misleading here.

[Response] Thank you. We will clarify the text.

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[RC1] Line 396 – "...that Henry Lamb was developing..." Here should be "Hubert Lamb", I guess. [Response] Well spotted!

[RC1] Line 626 – "...to define index categories: -/+180% for index values -3/+3, -/+130% for values -2/+2, and +/-65% for values +1/-1." Percent of what? This text is confusing. Please add more explanation. [Response] Thank you. We will clarify the text.

[RC1] Line 637 – add "decadal" otherwise not clear: "where... is the DECADEAL winter temperature index..." [Response] Thank you. We will clarify the text.

[RC1] Lines 694 – 695 "...the presence of key descriptors is used to distinguish these categories." Not clear, please re-formulate. [Response] Thank you. We will expand the text to clarify this.

[RC1] Line 696 – "Algorithms are then used to weight and combine documentary and instrumental data" Not clear, please re-formulate. [Response] Thank you. We will expand the text to explain this more fully.

[RC1] Table 3, 5 – There are some empty fields, please add something like "not available" or "not relevant" to avoid misinterpretation. [Response] Thank you. In the case of Table 3, the problem arises from having five index classes in the middle column and only four classes in columns one and three. We will review to see if we can present the table more clearly. For Table 5, we will add text to the table caption to explain the empty fields.

[RC1] In case of Table 5 please explain "qualitative indication" XXX means the best quality? [Response] Thank you. We will clarify this in the table caption.

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