“Climate indices in historical climate reconstructions: A global state-of-the-art”

Changes to manuscript in response to review comments – second revision

Response to Referee #1

The effort done by the authors to compile and summarize most of the scientific literature of the manuscript topic is highly valuable. Moreover, the article has improved a lot during the review process. However, I expected a deeper analysis of the indexing methodologies, but probably it is difficult to do all in the same manuscript. Anyway, I think that the manuscript could be published after take in consideration some minor points:

Response – We thank the reviewer for these comments. We have addressed all his/her minor points in the manuscript and trust that the paper is now acceptable for publication.

There is an incoherence among table 5 and the text. For example, table 5 indicates that there are no studies of droughts for Americas but in section 5.2 some works are cited:

Line 846 “Mendoza et al. (2007) constructed a similar series of droughts on the Yucatan Peninsula for the 16th to 19th centuries. Garza Merodio (2017) improved this index and extended it back in time (see Hernández and Garza Merodio, 2010), based on the frequency and complexity of rogation ceremonies (16th to 20th centuries)”.

Something similar occurs with the Snow/ice also in Americas, the table shows no studies but some works have been cited in section 5.3.

Response – The reviewer makes a useful point here. We have revised Table 5 in line with his/her suggestions by adding in scores of 1 under ‘Drought’ and ‘Snow/Ice’ for the Americas. We have also checked over the text for other regions and – as a result – added in a further score of 1 under ‘Snow/Ice’ for the Oceans.

I have some comments to the guidelines:

Point 7 “Where reconstruction must rely on a single observer or record, or on secondary sources, appropriate levels of uncertainty should be noted in the final reconstruction (see 12)”. I agree that secondary sources must be used carefully. But I am not sure that reconstruction based on a single observer or record has more uncertainties than reconstruction with more observers. In my opinion, this statement could be in contradiction with this paragraph of the manuscript:

Line 1024-1028 “indices are compiled from a unique documentary source – such as a private diary or diaries (e.g. Brázdil et al., 2008; Adamson, 2015; Domínguez-Castro 1025 et al., 2015), a series of correspondence (e.g. Rodrigo et al., 1998; Nash and Endfield, 2002; Fernández-Fernández et al., 1026 2014) or a series of acts of municipal and ecclesiastical institutions for a location (e.g. Barriendos, 1997; Dominguez-Castro 1027 et al., 2018) – it is easier to identify and correct unexpected bias or homogeneity problems”.

Response – The reviewer has correctly identified a potential contradiction in the text. Lines 1024-1028 (as quoted) are factually accurate. In Point 7, we were paraphrasing Pfister et al. (2018) but have clearly lost some of the meaning of the original text. We have revised Point 7 to read as follows (new text in italics):

“*If weather in a region is documented within a single contemporary record*, appropriate levels of uncertainty should be noted in the final reconstruction (*see Pfister et al., 2018*)”.

Point 8 “It is advisable to sum-up index series – either in time (i.e. from monthly to seasonal or annual) or in space (i.e. by combining several index series from a climatologically homogeneous region). This approach may well approximate index series to natural climate variability. Careful

assessment is needed, however, to avoid any loss of information during the process of summation, particularly for extreme events (see section 8.1)". First, are there any evidences for this affirmation: "This approach may well approximate index series to natural climate variability?" could you provide some references?

Response – Having revisited section 8.1 in light of the reviewer's final comment (see below), we have opted to delete the phrase "*This approach may well approximate index series to natural climate variability*" from Point 8.

Secondly, I agree with the authors that sum-up indices produce loss of information, but not only. In my opinion also can produce unexpected bias due to some "problems":
- The possible seasonal bias of the documentary sources. This problem is briefly commented by the authors at line 721, but it should be remembered here, because could be an important problem when sum-up series in time.

Response – This is a helpful point. We have added the following sentence to the end of Point 8: "*Potential seasonal biases within documentary sources should also be considered as these will influence annual totals*."

- In many cases the indexation only generates ordinal data as the authors mention in the manuscript. The ordinal data do not have metric information. Although we label each month numerically as '-2', '-1', '0', +1, +2 the numerals do not indicate equal intervals between levels. This could produce important caveats when we sum months. We do not know if the distant among -2 and -1 is the same than the distant among +1 and +2. Neither we know if this distance among levels is the same in the different months of the year. In my opinion this is a key point in the indexation and could be useful to be commented in section 8.

Response – This is a very good point. We have added the following text to paragraph 2 of section 8.1: "*It should be remembered, however, that indexation generates ordinal data, with no guarantee that the intervals between each index level are equal, so that the sum for a specific season or year can only approximate the magnitude of a meteorological phenomenon*."