**Climate
of the Past**

Discussions

EGU

Interactive comment on "Seasonal reconstructions coupling ice core data and an isotope enabled climate model – implications of seasonality, climate modes and selection of proxy data" *by* Jesper Sjolte et al.

Anonymous Referee #1

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The manuscript presents several reconstructions of climate fields in the North Atlantic over the last centuries. The reconstructions are based on proxy data on the one hand (oxygen isotope concentrations in Greenland ice cores and on European dendroclimatological data) and on climate simulations with a isotope enabled climate model. Both types of data are combined applying the analog method. The manuscript is mainly focused on testing the sensitivity of the reconstructions on the number of ice cores, on the definitions of the target seasons. The manuscript is less focused on the physical results and the implications of these reconstructions. It is therefore rather technical

manuscript. There are almost no results or dicussion on the physical mechanisms or past climate variations. This is in principle fine, but the readers should be made aware of this early on in the abstract and in the introduction. In my opinion, the manuscript addresses interesting issues. For instance, the use isotopic data from ice cores in combination with climate simulations to reconstruct the atmospheric circulation is an interesting idea. However, being this a more technical manuscript, the description of the methods applied leaves many open questions for the reader. This description should be considerably improved. At some points it is so unclear that I had doubts about the correct application of the method, although I hope that it is in the end correct.

Main points:

1. One main concern is the limited methodological description. The authors apply the analog method after a pre-filtering by Principal Component Analysis, but it is not cleat how this pre-filtering is actually conducted. Important questions that may impact the results :

1.1 Are the PCs calculated from the covariance of correlation matrix?

1.2 in Equation 1, are the PCS normalized to unit variance or has each PC the platitude representing the corresponding explained variance. This is important because this point represents two options: all PCs are equally weighted for the calculation of the distance of the analogues, or each PCs is weighted according to the varianve it represents. The selected analogues are different depending on the option chosen.

1.3 More importantly, for a correct application of the method, the EOFs patterns (derived from ice-core records and from model grid cells) associated to each PC in equation 1 must be the same . Otherwise, the PC-coordinates PC_{model} and $PC_{icecores}$) would not be linked to the same EOFs and therefore would represent coordinates in different subspaces. The calculated distances would not be meaningful. It may happen that the patterns of EOF_{model} and $EOF_{icecores}$ are very similar, in which case this problem would be minor. But this is not guaranteed. A way to en-

sure that the PCs in equation 1 refer to the same EOF patterns is to use, for instance, EOF_{model} for both data sets and calculate PC_{icecores} by projecting the ice core anomalies onto EOF_{model} . (Or viceversa, use EOF_{icecores} for both data sets).

This is the point that most strongly worries me. If EOF_{model} and EOF_{icecore} patterns are really different the whole application of the method is not correct, and all results should be re-calculated.

2. Another unclear methodological point is how the dendro data are included for the reconstruction. Here, I cannot make any useful suggestion because the authors approach remains unclear to me. This needs to be much better explained:

2.1 Are the analogues searched using ice-core and dendro data simultaneously, i.e. a 12-month-long model analog have to be close to the icecore data in the target season and close to the dendro-reconstructed summer temperatures in the summer season?. If yes, how is the EOF filtering implemented here? How many 'temperature' EOFs are used.

or

2.2 Do the selected analogues (using ice core data) undergo a secondary selection procedure targeting the dendro-reconstructed temperatures ?

2.3 In both cases, are the distances to the dendro-data and the distances to the ice core data equally weighted ? How is this implemented if the number of EOFs for each type of data sets is presumably not the same.

3. The validation of the results is essentially made by calculating the correlation between reconstructions and 20CR reanalysis. However, the amplitude of the reconstructions is not validated. This may be important because the amplitude of reconstructed variability may depend on the number of analogs selected: best-analog-selection (just one analogue) will roughly produce the same amplitude of variations, although the validation correlation will be lower; in contrast, using the mean of a larger number of

analogues subdues the variability, and this effect can be substantial when using 39 (?) analogues. There is an unavoidable trade-off between better correlations and more realistic amplitudes, as shown in Gomez-Navarro et al. Pseudo-proxy tests of the analogue method to reconstruct spatially resolved global temperature during the Common Era, Clim. Past, 13, 629–648, https://doi.org/10.5194/cp-13-629-2017, 2017).

Particular points:

4. We test a range of climate reconstructs varying the definition of the seasons

climate reconstructions

5. The abstract does not mention the reconstruction method at all, despite the manuscript being essentially methodological in nature.

6. best captured when defining the season December-February

the season as December-February

7. line 10 best captured when defining the season December-February due to the dominance of large scale patterns, while for summer the weaker, albeit more strongly auto-correlated, variability is better captured using a longer season of May-

This sentence becomes clearer later in the manuscript. Here, I would suggest to improve its clarity, for instance, using 'more persistent in time' instead of autocorrelated.

8. One point that sets the study by Sjolte et al. (2018) apart from the other studies mentioned in this section, is the use of

delete comma after section

9. line 145 For the summer reconstructions also using tree-ring data we sort the 39 existing ensemble members

I am rather confused by this sentence. The number 39 is mentioned here for the first time, if I am not mistaken. What are these ensemble members? are they the analogs

previously selected targeting the ice-core data ?

10. line 155 In this study we follow the convention of using the term PCs for the time series of the main modes of variability, while using the term EOFs for the spatial patterns of the modes. The method of Ebisuzaki (1997) is used to calculate the significance when

this sentence should appear before equation 1, at the very least

11. line 163 A key factor in how well seasonal climate reconstructions can represent climate itself, is the auto-correlation structure of atmospheric

climate itself ? I guess the authors mean to what extent can seasonal proxy data represent annual means ?

12. line 167 Figure 2 shows the monthly auto-correlation of each month of the PC-based NAO calculated from the 20CR. These figures show that during the cold season the

Which is the PC that represents the NAO ? Here, it is assumed that, for each month the leading PC is the NAO. In summer this is not always the case, and it depends on the geographical region selected to conduct the PCA.

13. line 180

circulation modes. We do this by performing monthly reconstructions for pressure and evaluating the resulting main modes of circulation against the modes of the 20CR. This is done using the same method as for the seasonal reconstructions,

what does 'evaluating the modes' mean here ?. The spatial patterns (EOFs) resulting from an analog reconstructions can be very realistic irrespective of the skill of the analog method. The analog method is just a resampling from a data pool. A random resampling of SLP from the 20CR reanalysis or from a model run will produce the same EOFs as the orginal data set, so even if the analog is wrongly implemented, the result-

ing EOFs may look correct. This is different for a temporal validation, e.g. correlation between reconstructions and observations, where the skill of the analog selection is critical. The authors should be here more specific.