Clim. Past Discuss.,
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Climate of the Past Discussions

Interactive comment on "The importance of input data quality and quantity in climate field reconstructions – results from a Kalman filter based paleodata assimilation method" *by* Jörg Franke et al.

Anonymous Referee #1

Received and published: 11 September 2019

General comments:

The manuscript describes results from a series of data assimilation experiments aimed at identifying the "best" tree-ring input data set, i.e. the one leading to the largest improvements in paleoclimate reconstructions of temperature, sea-level pressure and precipitation. Three data sets are primarily tested, differing in the level of screening applied to tree-ring proxy records with respect to their climate sensitivity. The topic addressed in the manuscript is an important one and should be part of the published literature on climate field reconstructions. Several issues are found however, which

should be addressed before the manuscript is published.

Issues believed to be most important are:

1- The title of the manuscript is somewhat misleading. It implies that a more comprehensive evaluation is presented, covering a wider range of proxy archives, while the study is restricted to tree-ring data.

2- The presentation of results is problematic in several aspects:

2.1- The evaluation of the reconstructions is restricted to the instrumental-era, based on comparisons with the CRU data set for temperature and precipitation. This leads to several questions:

a. The validation is performed with the same data set used for the calibration of the forward models. What is the impact of this lack of independence on the overall conclusions of the study?

b. An evaluation of reconstructions limited to the instrumental era does not provide a solid perspective of variability over longer time scales. For instance, Tardif et al. (2019) have recently shown that the selection of assimilated tree-ring width data sets leads to noticeable differences in reconstructed temperature variability at multi-decadal to centennial time scales, including the representation of notable epochs such as the LIA. Is the long-term variability in your reconstructions affected by the use of various tree-ring data sets and how? Are your results consistent with dependencies to assimilated data shown by Tardif et al.?

2.2- The use of global maps in the presentation of the results is not optimal. The proxy data sets and related impact are confined to northern Hemisphere as is noted in the paper, with no signal elsewhere. Please use maps of NH only, which would show the results more clearly.

2.3- The results are shown from the perspective of changes in verification scores in the reconstructions over corresponding values from the prior. You should show and

discuss prior verification scores to cast your results in their proper context.

3- The impact of assimilated data is usually tied to the particular forward models (here proxy system models or PSMs) used. Yet, there is lack of information about the performance of the various proposed PSMs, nor a reference to prior work is given which would provide the necessary information. A characterization of the PSMs themselves would help the reader gain a more complete perspective on the results.

More specific comments/questions are:

- Page 1, line 19: the use of "best possible" seems an overstatement. Perhaps you mean the best reconstruction given the parameters tested?

- Page 1, line 23: how is "insignificant" defined in the present context? Please clarify.

- Page 2, line 37: The use of "probably" is not appropriate. There is a large body of literature on the impact of input data on data assimilation results (mostly focused on weather applications however). I believe a more unequivocal statement would better convey what is already known about the importance of the quantity and quality of input data to data assimilation systems.

- Page 2, line 41: Could you better explain/justify why the study is restricted to tree-ring data?

- Page 2, lines 48-49: Reference to specific studies which support your "would always be beneficial" statement would help improve the manuscript.

- Page 2, lines 52-53: The statement including "which often results in a small sample, uncertain residuals and possible model overfitting" lacks support. Can you include references or show results that highlights these problems?

- Page 2, line 75: Is your statement about "no dating uncertainties" accurate? Perhaps "small dating uncertainties" would be more appropriate?

- Page 3, line 85: About the statement "experts from various regional groups were

differently strict in their screening procedure", has this been characterized in a more formal way? Please provide support for this statement.

- Page 3, line 86: You mention that "N-TREND is a collection of 54 tree-ring reconstructions". Do you assimilate the reconstruction data or the tree-ring data underlying the reconstructions? Please clarify. If you use the reconstructions, please justify.

- Page 3, line 93: Statement with "...simulate tree-ring observations using modeled temperature or precipitation": I believe you also use PSMs that include both temperature and precipitation as input. A more accurate statement would therefore include "temperature and/or precipitation".

- Page 3, line 95: You use a single seasonal response for all records, and for temperature and precipitation. Please justify.

- Page 3, lines 97-103: I do not easily understand the information provided in this paragraph. I would suggest revising the description of the PSMs, perhaps using equations or illustrations, to provide a description the reader will more easily understand.

- Page 3, line 109: The procedure described here amounts to some screening of the data that is not evaluated nor discussed further here. Perhaps it should be.

- Page 3, line 112: Please specify what is the source of the 30 ensemble members. This is not clearly identified here.

- Page 3, line 115: What is the localization applied when precipitation is involved? Please specify.

- Page 4, line 120: I am failing to understand the justification for using anomalies about 71-yr mean values, or the prior model states? proxies? Please describe and justify in more detail so the reader can understand.

- Page 4, line 124: Can you support the statement that the method is "expected to provide consistent skill at all time scales"?

- Page 5, top row of table, rightmost frame: Can you provide some evidence to support your statement that records “Probably included some moisture or partly moisture sensitive” ones?

- Page 6, lines 162-163, statement that “B14 provides temperature information in places where temperature is correlated with precipitation”: while most likely true, this statement seems incomplete. B14 also contains temperature sensitive records. One could argue that temperature improvements are mostly related to the assimilation of such records, more so than through the process you describe here. Can you support and quantify your statement?

- Page 6, line 183: regions (plural).

- Page 7, line 195, “lost”: I believe you mean “lowest”.

- Page 7, line 198: Can you provide a more complete reasoning as to why you believe overfitting is the (main?) reason for the behavior described in this paragraph?

- Page 7, lines 225-226, statement about problems on longer time scales: The experiments discussed in the manuscript are not evaluated on that particularly sensitive issue, an important shortcoming of the study in my opinion. The fact that results from your experiments can not provide a clear contribution toward characterizing or resolving this issue should be acknowledged.

- Page 9, lines 278-279: A more complete statement should include a reference to the work of Dee et al. (2016) to indicate that application of VS-lite has additional limitations related to model biases. (Dee, S., Steiger, N. J., Emile-Geay, J., and Hakim, Gregory J., 2016: The utility of proxy system modeling in estimating climate states over the Common Era, J. Adv. Model. Earth Sys., 8, 1164–1179, doi: 10.1002/2016MS000677)

- Page 9, line 288: data sets (plural)

- Including a figure showing the location of the proxy records from the various data sets would strengthen the presentation.

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