

Interactive comment on “A pseudoproxy assessment of data assimilation for reconstructing the atmosphere-ocean dynamics of hydroclimate extremes” by Nathan Steiger and Jason Smerdon

Anonymous Referee #1

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This paper uses established data assimilation techniques to reconstruct not only temperature but also hydroclimate variability. It carries out a perfect model study where both the prior information and target climate come from the same model (CESM) and employs a pseudo-proxy technique to carry out as close to a real-world based reconstruction as possible. This allows a validation of the method because by design the truth is known in advance. The paper looks at the ability of the technique to reconstruct temperature and drought globally as well as regional multi-year drought and ENSO. I find the paper well written and a good first step to what I am sure will be further studies

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that use this technique to make useful reconstructions of the real world climate.

My only main concern is that I do not think that the limitations of this perfect model study are made sufficiently clear. While in several places you mention that this is an “upper-bound on hydroclimate reconstruction skill” I think that this should be emphasised further, particularly in the abstract, but also while discussing the results. And it should be made clear that based on this study on its own you cannot tell if a skilful DA reconstruction is actually a possibility now, merely that it is theoretically possible. To this end I think that a section describing what uncertainty this technique includes and what it does not include would be very useful. For example the uncertainty in the pseudo-proxy parameter estimation is not included and because only one model is used model uncertainty is also not included. Given that there is model dependence in the moisture/temperature limitation sites (line 14 p 9) could this not be a real problem for this technique. To be clear, I have no problem with the results and techniques currently in the paper, and do not think that more work is needed, I merely think that slightly more detail is required to frame them in a more instructive way.

Apart from this I have only a few relatively minor comments (organised in roughly the order they appear in the text)

I think that title should be changed from “hydroclimate extremes” to “hydroclimate variability” to reflect the more general approach of the paper.

I found the description of the Kalman filter slightly hard to follow and think it could be improved by giving more information about what the filter is actually doing, in more accessible language so that a non-specialised audience can follow.

Do the matrices have a time dimension, or is the solution for each time step completely independent? This should be clarified.

Could multiple CESM ensembles be used for the prior information? Or does it have to be one continuous simulation?

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More information should also be given about the uncertainty matrix R. Has it only diagonal terms of 0.1? Where does this come from and what uncertainty does it include and does it not include?

Figure 2 and others – On my print out it is quite hard to make out the position of the proxy sites in some panels.

Figure 9 - What percentiles are shown in the box plots?

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