

Clim. Past Discuss., author comment AC2  
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## Reply on RC1

Duncan Pappert et al.

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Author comment on "Statistical reconstruction of daily temperature and sea level pressure in Europe for the severe winter 1788/89" by Duncan Pappert et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2022-10-AC2>, 2022

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**Thank you very much for your Review. Below are the replies to the comments raised.**

**Comment 1) The annual cycle is removed by filtering out the annual frequencies. However, the analogs themselves are chosen from candidates with a calendar date within a temporal window centered on the target. I wonder whether the filtering of the annual cycle is really necessary, since all analogs candidates are located in the same 'season' as the target. I do not think the filtering is damaging, but in my view it is not necessary. Perhaps the authors may like to add a couple of sentences to inform the reader**

Reply 1) The reviewer notes that the subtraction of the annual cycle may not be necessary since anyway a seasonal window is specified. We will add information on that. Note, first, that this only concerns temperature (pressure is not deseasonalized). Basically, the subtraction of the annual cycle increases the size of the analog pool. This arguably does not matter for most cases, but it does for extremes, as for this extreme winter 1788/89.

Comment 2) Background state in the EnKF. The background state is chose as the best analog. I also wonder whether this is consistent with the calculation of the covariance matrix using all n-nearest neighbour analogs. It seems to me more logical to choose either the average of all n-analogs or possibly the member of the analog ensemble with median distance. Again, perhaps the auhors may want to comment on this

Reply 2) We prefer to work with one analog as this is physically consistent, while an average of analogs is not necessarily physically consistent. Of course, we could choose all n closest analogs as background and update them using the covariance matrix of n analogs and then do the ensemble mean (which again might not be physically consistent). We will discuss this in the revised manuscript.

Comment 3) The Kalman filter set-up is generally used to combine two independent estimations, for instance one from a model run and one from a noisy observation. Both need to be independent for the method to be statistically sound. Here, however, both estimations are not independent: one is the best analog, which uses the observations, and the second is the observation itself. Thus, the separation is not clean, if I am not mistaken.

I would not be very picky here, since the authors test their results with independent observations and the method, pragmatically, indeed works: the EnSK is able to improve

the analog-based estimation. However, the more theory-inclined reader may frown upon this dependency. The authors may again want to include a warning or a comment.

Reply 3) The reviewer is correct that the background uses the observations; it is basically an interpolation of observations. However, the target day (and surrounding) is excluded from the pool of analogs, so we never assimilate observations from the same date. We will add a sentence to be more clear on that.

Comment 4) ' The RMSE also shows an improvement from 3.4 to 2.7 °C, as does the mean bias from 0.67 to -0.13'

Reply 4) Thanks the unit is °C. We will add that.