EGUsphere response to reviewer 1

https://egusphere.copernicus.org/preprints/2023/egusphere-2022-1385/

Major Comments

The SVD-based common EOFs method used in the paper is akin to the combined EOFs (e.g., Navarra and Simoricini 2010) where the different datasets are packed in one single large array, which is then analysed via SVD. Of course the difference is in the way the data bloc matrices are arranged in the large array. The result is a set of individual eigenelements (i.e. EOF in S-mode as in Barnett (1998) and also here, or PC in T-mode as in combined PCA, see, e.g. Jolliffe (2002)) associated with corresponding eigenvalues. The original common EOFs method as presented first by Flury (1984, 1986), see also Hannachi (2021) for earlier literature, analyses different covariance matrices, for which one common EOF has different explained variances depending on the data (or model run). Clearly this version gives more degrees-of-freedom to the common EOFs compared to the one defined by Barnett (1998) or here where one common EOF has one single explained variance for all the models' simulations. One benefit of the former is that these eigenvalues --for one given common EOF-- can be made useful to weigh the different models, and can be used in various other ways, e.g., to get the models' climatology. In addition, it overcomes the issue of scaling in the different datasets.

Of course I must say though that the SVD-based common EOFs (Barnett 1998 and the present manuscript) is computationally much faster and is convenient for application with large number of GCMs runs as in this paper. I think these points, with the above references highlighting the historical context of common EOF/PCs should be included in the revised version. In Hannachi et al. (2022) the references we mentioned there are more related to climate research. Some other references (e.g., Barnett 1999) were missing because the search engine did not find them as they do not mention common EOFs/PCs in the title. In any case, the first time common EOF/PCs was mentioned was in Flury (1984).

Thanks for this valuable comment and the additional list of references - it's indeed important to acknowledge relevant work and give credit to past scientific effort. The cited work will be included in the revised final paper.

Minor Comments

Pg 3 - Please change TAS to SAT (surface air temperature) and PSL to SLP (sea level pressure) in page 3 and elsewhere. **- I understand the preference to use SAT and SLP, however, we thought it still may be better to use the standard variable names from the CMIP archive.**

Pg 3, l71: 'vector' --> 'value' **- changed. Thanks for spotting this mistake.**

Pg 6, near l171, l175 - repetition. **Thanks - the text has been revised.**

Fig 5, top panel: y-axis label: add "Relative (or scaled) rank". **I am unfamiliar with the term 'relative rank', but think that the word 'rank' is in line with Ranking in statistics as described in https://en.wikipedia.org/wiki/Ranking**

Pg 8, l240 - ensemble spread cannot be normal - could be truncated normal perhaps. **Fig. 8 suggests that the ensemble distribution is approximately normal except for some exceptions. But, why can't ensemble spread be normal - because the ensemble members are bounded random variables from either below or above?**

Fig. 8, I presume there is one value per model, right? Is it global mean of the climatology? **Yes, and the points represent the mean for a given season. The revised paper will make this clearer.**

Fig. 9, top left and bottom panels, units: oC/yr **- °C/decade, thanks for pointing this out. The revised paper will make this clearer.**

References

Flury B.N., Common principal components in k groups. J. Am. Stat. Assoc., 1984.

Flury B.N., and W. Gutchi: An algorithm for simultaneous orthogonal transformation of several positive definite symmetric matrices to nearly diagonal form. SIAM J. Sci. Stat. Comput., 1986.

Hannachi, A., Pattern Identification and Data Mining in Weather and Climate, Springer Nature, 2021.

Jolliffe I.T., Principal Component Analysis, Second Edition, Springer Nature, 2002.

Navarra, A., and V. Simoncini, A Guide to Empirical Orthogonal Functions for Climate Data Analysis. Springer, 2010.