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Interactive comment on "Multivariate bias corrections of climate simulations: Which benefits for which losses?" *by* Bastien François et al.

Anonymous Referee #2

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General comments:

1) A comparison of methods is especially helpful in an emerging area of research such as multivariate bias correction (MBC), where few guidelines are available. Overall, I like the article but have some suggestions for improvement.

2) I was surprised that the authors re-gridded the 0.5 degree precipitation product to the coarser climate model grid using nearest neighbor interpolation. The authors don't say what method is used for the 8km precipitation product, but presumably that also is nearest neighbor? Overall, this approach seems to ignore a lot of spatial information in the "observed" data and effectively makes this a quasi-regular resampling of the observed data and not an interpolation. Is the goal to get area-averaged precipitation or a gridded product of point precipitation? Some discussion of this choice and the

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tradeoffs is warranted, unless the authors decide to use a different approach.

3) A lagged version of a variable, whether spatial or temporal, can be thought of as just another variable. Adding a lagged variable to MBC, therefore, is just MBC. As a result, I think the results that show the impacts of poorly conditioned matrices is the key takeaway here. One should parsimoniously add variables that are important to preserving the kind of variability that one is most interested in. For instance, if heatwaves are of interest, then one should emphasize temporal correlation. I'd like to see a bit more on the tradeoffs between emphasizing temporal vs spatial correlation, in terms of choosing the dimensionality of the bias correction. The authors touch on this in the discussion, but some more specific guidance for making these choices would be helpful.

4) Given that the methods use covariance (which is the basis for Pearson's correlation) to constrain the bias correction, it seems somewhat inconsistent that Spearman's correlation is used to evaluate how well the various methods preserve the inter-variable "correlation". I understand the reasoning for using nonparametric correlation, but it also raises questions about what the goal of the bias correction should be. That is, should bias correction preserve covariance in instances where covariance can't reliably be estimated?

Specific comments:

1) The article is mostly well written, but there's some awkward phrasing here and there including the Abstract (e.g., "climate variables evolutions", "not well apprehended") and elsewhere ("permits to relate").

2) "methodology" refers to the study of methods. The authors should just use "method" wherever they have "methodology".

3) The last paragraph of the Introduction can be deleted (this structure is obvious).

4) Section 2: "RPC" should be RCP.

5) The framework for the CDF-t method described in text and in Appendix A seems to be a generic accounting of quantile mapping. What I didn't see was information on the transfer function itself (i.e., what criteria determine the degree to which the two distributions are required to match).

6) Table 1 is a helpful summary of the bias-correction methods, but it's hard to match it up with the several pages of text and the Appendices to try to figure out what makes them distinct. There seems to be a gap between describing the general characteristics of the methods (Table 1) and the lengthy text-based descriptions. Please consider adding another table (or other information to Table 1) that helps to determine the specific attributes that makes the methods distinct.

7) At the beginning of Section 4, it would be helpful for the authors to outline what using the three different designs (2d, spatial, and full) aims to accomplish. Which approach has been more commonly used in the literature? Some of the dimensionality tradeoffs could be introduced here as well.

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