

Geosci. Model Dev. Discuss., referee comment RC2
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Comment on gmd-2022-237

Anonymous Referee #2

Referee comment on "Evaluation of bias correction methods for a multivariate drought index: case study of the Upper Jhelum Basin" by Rubina Ansari et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2022-237-RC2>, 2023

In their study, the authors of "Climate change projections of wet and dry extreme events in the Upper Jhelum Basin using a multivariate drought index: Evaluation of bias correction" assess the performances of several univariate (2) and multivariate (8) bias correction methods applied to climate models outputs for impact studies. The multivariate drought index SPEI is considered to evaluate the adjustments of wet and dry extreme events over the Upper Jhelum Basin, in the Western Himalaya region. Two experiments of bias correction are performed in this study: 1) the component-wise approach that consists in applying bias correction (BC) methods prior to the computation of the SPEI index, and 2) the direct approach that consists in calculating the multivariate SPEI index first, and then adjusting it using univariate BC methods. Corrections are performed to adjust daily maximum temperature, minimum temperature and precipitation from several CMIP6 GCMs, CORDEX and CORDEX-CORE RCMs with different spatial resolutions over the historical period (1986-2005). Corrections are evaluated in terms of inter-variable relationships and SPEI characteristics on the same historical period with respect to W5E5 reanalysis dataset. The authors find that the multivariate BC methods have some added value over univariate BC methods concerning the adjustment of inter-variable properties. However, both univariate and multivariate methods present similar performances for the correction of SPEI indices. The direct approach shows slightly better results than the component approach and no added value was obtained when considering high resolution products.

The article is scientifically interesting, its structure is clear and easy to follow, the results are well explained and summarized. I think this study certainly falls within the scope of the journal. However, I think there are a few minor issues that should be considered to improve the study before publication.

General comments:

1. SPEI has been chosen to evaluate univariate and multivariate bias correction methods. In this study, the index is computed in several steps involving precipitation, Tmax and

Tmin time series at different time scales. Thus, not only a good representation of the values (marginal properties) and dependence (inter-variable properties) of the variables is important for the SPEI index, but also the temporal properties. None of the multivariate BC methods used in this study are designed to adjust temporal properties. Moreover, multivariate BC methods can also deteriorate temporal properties (e.g., François et al., 2020). Consequently, it is not clear in this study whether the comparable performances of multivariate BCs with respect to univariate BCs are due to compensating effects between improvement of inter-variable properties with multivariate BC and deterioration of temporal properties at the same time. Would the same conclusions be obtained by considering other multivariate indices than SPEI, e.g., indices for which inter-variable properties are important, but not temporal ones? I think that these points (1. importance of temporal properties for SPEI, 2. inability of the implemented BC methods to adjust temporal properties and 3. potential deterioration of temporal properties by multivariate BCs) should at least be mentioned in the discussions to provide some nuances to the conclusions of this study as explained above.

2. I really like the title which is clear but I find the term "climate change projections" a bit misleading. The historical period 1986-2005 is only considered in the study, and thus authors are not looking into climate projections, i.e., simulations of future evolutions of the climate system. The notion of "climate change" is also misleading as the changes of the climate system are not particularly investigated in this study, not even those that could have occurred during the 1986-2005 period. I would propose to find another title for the study avoiding the words "climate change projections".

3. In Section 4 - Discussion and conclusion: I really like the way results are summarized and discussed. However, I think it would be interesting to detail a bit more about future research by adding a few sentences. Besides investigating the robustness of results under climate change as already mentioned at the very end of the study, what are the next steps of this work? I think it would be helpful to mention a few avenues of research, as it would help to better connect this work to the research community.

Specific comments:

- Page 2, L21: "The use of raw GCM and RCM output for subsequent impact studies without any post processing could lead to ill-informed adaptation decisions for the foreseeable future.". Do you have any examples/references to support this sentence?
- Page 4, L20: "above/below 1". I assume you meant "above 1 and below -1"?
- Page 5, Table 1 and 2, and Section 2.4: I don't understand why you detail the scenarios for the different models. As your study is focused on the 1986-2005 period, it seems that there is no particular reason to provide such details. It might be preferable to remove some parts of the text and tables mentioning information on scenarios.
- Page 5, Table 1: It might be preferable to round resolution numbers in the table.

If needed, I would be happy to review the revised manuscript.