Geoscientific
Model Development
Discussions

Interactive comment on "A new region-aware bias correction method for simulated precipitation in the Alpine region" *by* Juan José Gómez-Navarro et al.

Anonymous Referee #1

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General comments:

The paper is well written and addresses a relevant scientific question by describing a promising bias correction method, based on quantile mapping (QM) conditioned to regions with similar temporal variability. It is in general well-structured and represents a substantial contribution to the modelling and impacts community. Still there are some explanations missing to be able to understand the whole methodology and these explanations may probably answer some of my specific comments. In particular, the regions/clusters are obtained for observations and model independently, I do not understand how the bias correction is trained and applied for each grid box, since the

regions are different for each dataset and a grid box may belong to different clusters in both datasets. Thus, how are the calibrated corrections obtained for a region? Which correction is applied to a grid box that belong to different regions in the model and observations? And some further issues:

1) If the cluster classification of the raw model data is used, this classification is based on biased data.

2) If only the classification for the train/test of the QM based on observations is used, how would be the method applied in a changing climate in which the grid boxes could move to another cluster?

3) Can one relate those "objective" clusters to e.g. hydrological catchments relevant for impact studies?

4) How does the different number of grid boxes in each cluster affect the results? The authors may include the number of grid boxes per region in Fig.2.

A further concern is if the authors checked differences/improvements with respect to standard QM (without conditioning to regions). Some discussion about this would be appreciated.

Here I list some specific comments and typos, giving the page and line numbers.

Specific comments:

P1 L6 "minimise disturbances to the physical consistency" -> not clear, please rephrase or elaborate.

P1 L16 which variables? So far only precipitation was mentioned (also in the title). If the clustering depends on the variable, why does the method preserve the physical consistency among variables more than the standard QM?

P2 L3 The authors may consider citing the newer analysis including EURO-CORDEX data: Rajczak, J. and C. Schar (2017), Projections of future precipitation extremes over

Europe: a multi-model assessment of climate simulations | J. Geophys. Res. Atmos., doi:10.1002/2017JD027176.

P3 In the review of bias correction methods, the authors may consider the following paper, with some similarities from a technical point of view, where the bias correction is conditioned to circulation types: Wetterhall, F., Pappenberger, F., He, Y., Freer, J., and Cloke, H. L.: Conditioning model output statistics of regional climate model precipitation on circulation patterns, Nonlin. Processes Geophys., 19, 623-633, https://doi.org/10.5194/npg-19-623-2012, 2012.

P3 L15 After this paragraph I suggest to include a sentence mentioning the implications in the climate change context, something like "As a consequence, the climate change signal might be unrealistically modified", as stated e.g. by:

Casanueva, A., Bedia, J., Herrera, S., Fernández J. and Gutiérrez J.M. Direct and component-wise bias correction of multi-variate climate indices: the percentile adjustment function diagnostic tool. Climatic Change (2018) 147: 411. https://doi.org/10.1007/s10584-018-2167-5

Teng J, Potter NJ, Chiew FHS, Zhang L, Wang B, Vaze J, Evans JP (2015) How does bias correction of regional climate model precipitation affect modelled runoff? Hydrol Earth Syst Sci 19(2):711–728. https://doi.org/10.5194/hess-19-711-2015

P3 L16-20 The authors may consider the above paper (Rajczak and Schar 2017) to update that summary of previous works.

P3 L20-21 what do the authors mean with "similar"? different model version? Parameterizations?

P3 L16-25 I would suggest to move the entire paragraph before the previous one, in which bias correction is introduced, since it reads better after line 3 and here it is again about previous studies in which bias correction is not applied. Also the final lines of the paragraph (23-25) are more or less repeating what it is already said in P2 L34.

C3

P5 L24 Is there a reason for using 27 years instead of e.g. 30?

P7 L7 I suggest to add "smooths out the transfer functions prior to the correction".

P7 L9 Until now it is not clear which is the analysis domain, the title says Alpine region, simulations are performed for the Alpine region but observations are available for Switzerland. Please consider to mention Switzerland explicitly in the experimental design and title.

P7 L16 As mentioned before, the authors mention the preservation of physical consistency. My question now is how coherent is the method in a multivariate case? I guess a different division in clusters would be performed for each variable. Can the authors comment something on this?

P7 L21 "varies per season" why seasonally? In section 3 it is said that the method is applied for each month, thus one expect to have different clusters at the monthly scale.

P8 L13 The authors mention several times the insufficient effective resolution of the observations, what about the effective resolution of the simulations? The authors should include it in the discussion as well.

P8 L15-35 The authors should motivate better the correlation analysis in Fig.3. I do not see the point of this analysis, especially since the clusters are built in a way that the differences among clusters are maximized. Moreover, the clusters are different in each dataset, so there is not a clear correspondence. This lack of correspondence is only mentioned and resolved in Fig.4.

P9 L31 "averaged over Switzerland" Given the differences in the annual cycle among the regions, the authors may consider doing this analysis per cluster, based on the observations or the WRF-ERA classifications.

P10 L1-8 The underestimation of precipitation in the Ticcino during autumn is worth to mention. Can the authors give a reason for this?

C4

P10 L12 The authors should also explicitly mention in the methods how the precipitation frequency is adjusted by this method (relevant for the interpretation of Fig.7). Standard QM is able to correct for a higher frequency of wet days in the model, but the opposite problem (here shown in Fig. 7, winter) could be corrected by applying the frequency adaptation, otherwise an overestimation of the wet day frequency is found in the corrected data. See : Themeßl, M.J., Gobiet, A. & Heinrich, G. Empirical-statistical downscaling and error correction of regional climate models and its impact on the climate change signal. Climatic Change (2012) 112: 449. https://doi.org/10.1007/s10584-011-0224-4

P12 L4 Why are the temporal correlations lower in autumn? This may be related to the way the corrections are trained and applied.

P22 Fig.4 The decimal dots are missing in the labels of the Taylor diagram. And more important than that, it is completely unclear to me what is shown by the angular scale (azimuthal angle). I would expect to have represented there correlation values but that legend must be something else. Please explain in the caption how this should be interpreted.

Technical corrections:

P1 L1 Do the authors mean better than the coarse global models? I suggest to include better than what.

P1 L13 I think the sentence will read better with "Conversely, WRF-CESM shows a different seasonality..." This is only a suggestion.

P2 L2 I think it would be "burden with".

P2 L12 "precludes the simulation following ... " -> "precludes the simulation from following...".

P2 L25 "and in variables where the..." -> "and variables for which the ..."

P2 L28 "with the help of" -> not sure if "the" should be omitted.

P2 L32 Add "change in spatial resolution", since it is the first time that this issue is mentioned.

P3 L2 "a major source of uncertainties" -> not clear to which part of the previous sentence this is referring to. I suggest to add "being a major source of uncertainties..."

P4 L5 I think "the" in "bias-correct the precipitation" should be removed.

P5 L7 "analyses ... is" -> "analyses ... are".

P6 L17 "distances ... needs" -> "distances ...need".

P6 L32 "quantiles from 1st to 99th are corrected". Note that percentiles and quantiles are not the same, I think here the authors refer to 1st to 99th percentiles.

P9 L10 "differences also appears" -> "differences also appear".

P9 L12 Not sure if the authors should include "the" in "observations is the best".

P9 L22 Sentence "The spatial structure ..." Please rephrase this sentence. If the observations are considered as the truth, I do not understand that "the spatial structure is well reproduced" by them. "correlations are slightly larger", than what?.

P9 L25 "gridded product", the simulations are also gridded, so here I would add "observational gridded product".

P10 L14 "binning" -> do the authors mean "binding"?

P12 L10 "Alpine area" -> I would suggest to talk about Switzerland.

P13 L3 "questions where" I would say "questions for which".

Table 1 (caption) "variance explained" -> "explained variance".

Interactive comment on Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2017-329,

2018.

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