Re-evaluation of the manuscript

A new bias-correction method for precipitation over complex terrain suitable for different climate states: a case study using WRF (version 3.8.1)

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General comments:

The body of the manuscript in its present form describes an extension and modification of a bias correction method (Empirical Quantile Mapping, EQM) for a regional climate model with application over areas with complex terrain and past climatic periods with changed orography. The manuscript is well written and the method is described, validated and comprehensively discussed under present-day climate conditions. In the present form however, an important part of the analysis – the application and consistency test with Last Glacial Maximum (LGM) conditions and simulations – is still missing. This part should be presented in greater detail by adding a dedicated full chapter on the LGM simulations and according application of the method to assure the robustness and added value of the method.

Abstract:

A good and concise summary, but for the general audience maybe one or two sentences on some hypotheses that could be better addressed concerning the LGM-PD climatic differences. i.e. changes in human occupation and migration routes, implications for interpretation of hydro-sensitive proxies etc. to put the work into a broader context (even the empirical evidence is very sparse). The most important point, the application and presentation to LGM conditions and consistency checks with empirical data is still missing.

Introduction:

The introduction is quite technical towards the modelling side. Maybe the authors can add some general remarks on basic climate differences between present day and LGM, i.e. mean temperature differences. A zoom of the glaciated area over Switzerland would also be interesting to see in a plot.

In addition, some hints to proxy studies are missing, e.g. what is the benchmark and/or any hypotheses that could be addressed specifically with the study and the method. Those questions do not necessarily need to be all addressed in this study, but it would be important for the general audience to see an applicated and added value of the technical work of the bias correction.

Concerning the stationarity assumption: What are the most important challenges violating the stationarity assumption ? (e.g. differences in lapse rates Present day-LGM, influence of albedo on temperature profiles, general lower availability of moisture and precipitable water during glacial times, changes in circulation, importance of circulation and other biases of the driving model etc. how are changes in vegetation cover treated as an important source of moisture-recycling).

Please just mention those issues to put the precipitation bias correction into perspective in concert with other, competing and maybe evening cancelling factors, complicating the eventual validation on bias corrected results with data based on empirical evidence and other modelling approaches.

An interesting question for future studies that might be mentioned is how the changed precipitation itself could alter maybe even large-scale climate in terms of soil moisture and/or snow-albedo effects that cannot be accounted for after the bias correction is applied.

Model and Data:

The general setup seems to be very innovative and is an original approach for this time slice by implementing a simulation with 4x4km over the highly complex terrain over the alpine region.

A very meaningful implementation in the setup is the very conservative downscaling factor of 1:3, addressing the different meso-and local scale features that cannot be reproduced using a more liberal conversion strategy by leaving out some nests.

Validation of the method:

For present day climate conditions, the method is very rigorously tested and testing/validation is reported in a very detailed and concise way. Unfortunately, the LGM (with altered topography forming the test bed and a central part of the study) is only hardly addressed in a very short last paragraph. The added value, also leaving out the LGM, seems to be the height-class dependent quantile mapping for present day climate. For the reader, however, the direct comparison to a classical EQM is missing in Figures 5–7. This analysis would be helpful in order to assess the advantage of the new bias correction method.

Conclusions:

The conclusions mostly pertain to situation of present-day with unchanged topography. The LGM is only hardly presented, although focus is set on changes in topography. Therefore it would be really important to show more results of the LGM. In the present form, the conclusions present more or less a repetition and summary of the validation of the methods section.

I suggest adding a dedicated results section on the added value including more material of the LGM simulations and for comparison at least some studies based on empirical evidence. In the present form I think the manuscript presents too little original and robust information/analysis that the method is outperforming classical EQM methods to qualify it as a comprehensive scientific paper.

Additional references and sources for comparisons with LGM

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