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Discussions

Interactive comment on "Technical Note: The impact of spatial scale in bias correction of climate model output for hydrologic impact studies" *by* E. P. Maurer et al.

Anonymous Referee #3

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Review of "Technical Note: The impact of spatial scale in bias correction of climate model output for hydrologic impact studies" by E.P. Maurer, D.L. Ficklin, and W. Wang This study investigated the impact of spatial scale at which the quantile-mapping bias correction is applied, on the streamflow produced by a hydrologic model. Daily precipitation and maximum and minimum surface air temperature from the NCEP/NCAR reanalysis were bias corrected against the gridded observations at spatial resolutions of 0.125, 0.25, 0.5, 1.0 and 2.0°. The bias-corrected variables were then interpolated to 0.125° grid before inputting into the SWAT hydrology model to simulate streamflow across the Western United State. Skill was evaluated by comparing the simulated

streamflow using bias-corrected reanalysis data with the gauge observations. It was found that while bias correction at the coarse resolution (2.0°) produced the least correspondence with observation-driven streamflow, increasing the spatial resolution to finer than 0.5° for bias correction did not improve skill and even degraded skill. This is a well-written paper that explored how bias correction at different spatial scale affects streamflow estimation skill. The methodology is robust and valid. I have only a few questions about the paper. While the bias correction performed at 1° gives the best skill in streamflow estimation for a river basin with approximately 1.4° spatial scale (i.e. the Sacramento River), 0.5° is the optimal scale to apply bias correction for a smaller basin with 1/3° spatial scale (i.e. the Tule River). The authors stated that there is no clear relationship between drainage areas and the skill (defined by the p values). I would suggest if the authors could show a p-value versus area plot. The methodology involves a few times of interpolation. First, the observations and reanalysis data were interpolated (or downscaled) to the same resolution on which bias correction was applied. The corrected data were then interpolated to 0.125° resolution before inputting into the SWAT model. How much uncertainty was introduced by the interpolation? Next, there is evidence of change in the spatial distribution of rainfall, atleast in the case of extremes that are often important for hydrologic simulations. An example of this is presented in (LI, J., SHARMA, A., JOHNSON, F. & EVANS, J. 2015. Evaluating the effect of climate change on areal reduction factors using regional climate model projections. Journal of Hydrology, 528, 419–434.). I believe, for completeness of this evaluation, this needs to be acknowledged in the presentation being made here, along with a discussion of how the inputs being used in this study correspond with the type of changes it suggests. The conclusion that bias correction at scale of 0.5° produced best skill in streamflow estimation is based on comparing the SWAT output with gauge observations. Have the authors taken into account the bias caused by using SWAT model (i.e. the discrepancies between the SWAT output based on observed data and gauge observations)? If this bias is also non-stationary, how will it interact with the bias in climate model simulations? For example, if the bias of the SWAT model for the validation period is larger than that for the calibration period, whereas the bias of climate model at 0.5° resolution for the validation period is smaller than that for the calibration period, then these two kinds of bias can cancel out with each other for the validation period. This will lead to the conclusion that performing bias correction at 0.5° resolution is optimal in terms of streamflow skill. But if other hydrological model is used, the same conclusion may not hold. This brings me to a question about the importance of the quantile mapping approach the authors use here. This approach scales precipitation inputs differently for difference cells that are adjacent to each other. Consequently, one can expect the original spatial dependence structure of the atmospheric variables that are used in downscaling are corrected to different extents, forcing a mis-match of their modelled dependence structure and causing implications in the quality of the downscaled simulations obtained. I personally do not like quantile mapping as a bias correction alternative for this reason and would rather trust an approach that corrects the GCM field ensuring the multivariate dependence is intact. There are approaches that do this (MEHROTRA, R. & SHARMA, A. 2015. Correcting for systematic biases in multiple raw GCM variables across a range of timescales. Journal of Hydrology, 520, 214-223.). There are also the Nested Bias Correction approaches that address biases across multiple temporal scales which are of great relevance when simulating flows or soil moisture for agricultural applications. I believe the authors need to broaden their discussion about these issues and the impact of the quantile mapping bias correction they have used.

Lines 1-3, Page 10899: How were the bias corrected anomalies calculated? Were the anomalies calculated by removing monthly mean or daily mean from the bias-corrected daily time series?

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