Hydrology and Earth System Sciences Discussions

Hydrol. Earth Syst. Sci. Discuss., referee comment RC2
https://doi.org/10.5194/hess-2021-236-RC2, 2021
© Author(s) 2021. This work is distributed under
the Creative Commons Attribution 4.0 License.

Comment on hess-2021-236

Anonymous Referee #2

Referee comment on "Impact of correcting sub-daily climate model biases for hydrological studies" by Mina Faghih et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-236-RC2, 2021

Review of “Impact of correcting sub-daily climate model biases for hydrological studies”, Faghih al.

In this paper the authors present a study on bias correction of precipitation and temperature projections at the sub-daily scale, noting that bias correction of these variables is a necessary ingredient to reliable projections of the hydrological response of catchments to climate change. Overall the paper is well structured and written and the topic is relevant and interesting to the readership of this journal.

General comments:

While the research that is developed is as said well developed and interesting, I was perhaps a little disappointed in the discussion of the results, which although they highlight to some extent the findings, their could have been a little more depth in the exploration of the results, and how these relate to the particular hydro-meteorological processes in the set of catchments considered. The MOPEX dataset is a well-established dataset, and has been studied widely, which also means there is a lot of research to benefit from to support a more in-depth discussion. The main explanatory variable that the authors propose is catchment size, but I could imagine there may well be other explanatory variables. The catchments selected are in a relatively concentrated geographic area, but I would also expect that there may be quite different dominating hydrological processes. I would for example assume that some of the catchments around the Southern great lakes are dominated by spring snowmelt and perhaps convective storms in the summer, while the more coastal catchments east of the Appalachians may well be dominated by frontal precipitation from mid-latitude storm depressions. I myself am not an expert in the climate nor the hydrology of the Eastern USA, but I could imagine that the relative importance of these different hydro-meteorological processes is relevant to the bias correction of precipitation and/or temperature.

It is also clear in the diurnal precipitation patterns, that JJA rainfall is largely convective and thus falls in the afternoon/evening, while in the remainder of the seasons it is perhaps more frontal in nature. How the different types of rainfall that are dominant in a catchment and how this changes may also be important to biases and their correction. Resolution of convection is raised in the introduction, but not discussed much further.

I think the discussion could be much strengthened if the author would go beyond catchment size as the explanatory variable. Perhaps it is the case that it is indeed the most significant influence in explaining how important the bias correction is, as well as the bias correction of either variable, but it is worth exploring, and the interest as well as the scientific contribution of the paper would be benefitted by at least some discussion of the different hydrological characteristics of the selected basins. I am sure that there is sufficient other research on the characteristics of the MOPEX dataset to support such a discussion. I would recommend the authors revise the discussion section to provide more depth and insight into the proposed bias correction methods through the lens of the hydro-climatology of the catchments. I feel some findings are not well addresses (see detailed comments) due to this lack of depth from this perspective.

Detailed comments:

Line 52: The authors comment that many GCM and ESM have coarse resolutions of up to 100km (order 1 degree). I would think that it would be better to refer to the resolution in degrees (as this is common practice). Also, this is a fast-moving field, and the resolution of such models has decreased gradually and continues to do so (see e.g. discussion on the convergence of GCM and ESM by Bierkens, WRR (https://doi.org/10.1002/2015WR017173). Also, the HTESSEL model that underlies the ERA5 data that the authors use could be considered a coupled ESM/Land Surface Model (LSM), and has a higher resolution. It may be good qualify the comment here, but also to include this in the discussion. Will this gradual decrease in resolution in space and time reduce the need for such bias correction as proposed here?

Line 110: The figure presenting the different catchments could be bit more informative. The size of the circle as well as the colour are now used to indicate how the catchments fall in the different categories. One of these dimensions is redundant. As there are some larger catchments, the division across the three scales the paper focuses on is not clear. One could perhaps use a different symbol (square, circle, triangle) for the category and colour for the size would be more informative. It is also clear from the table that the sample of small catchments is in fact quite small. How well are these spread over the different hydro-climatologies, or are they concentrated in the more mountainous Appalachians (it is not so clear in the figure)?

Lines 180-185: The authors present the setup of the calibration the model using SCE-UA

and N-S as a performance indicator. I think this is an approach reasonably familiar to the HESS readership, so in some cases the description could be more brief (e.g. one could consider leaving out the equation and simply providing a reference). I am also fine with the fact they do not split the sample, considering that a well calibrated model is important but it is not the focus of the study. However, that does raise the question on how this was organised for the bias correction approach. Was a split sample used? This is not clearly described (in the previous section). On line 215 mention is made that if the bias correction was applied at the hourly time scale, then this would have fitted the observations exactly (for the mean I would assume). This suggest that a split sample is not used, thus raising the question of how well the corrections applied are a generalisation of the biases. This may warrant some discussion.

Line 262: Figure 5 is not very easy to read. It is mentioned that the light blue curves overlap – but it is very difficult to identify what is what in the figure. This could well be improved. It is also not fully clear of the average biases, as the lower part of the different lines is obscured. Given the information the authors want to convey, would it perhaps be more appropriate to present in the form of a flow duration curve? This may well not show the full variability, but it does provide information on the average annual spread. I would suggest the authors try in any case to make the figure a little clearer.

Line 271-274: I think it is important here to be explicit on the question if the climatic characteristics and the dominant processes that shape the regime (pluvial – nival) of the two catchments compared are indeed similar, thus supporting the claim that the diurnal variability being more apparent in the smaller catchment is indeed attributable to catchment size.

Line 288: Please check the description of the Figure 7. The red crosses appear to be circles. Also, there is a pink/purple cross that is not explained which I assume is the mean of the distribution.

Line 297: Figure 7 shows the relative biases of the small, medium and larger catchments after bias correction. The unbiased model results are not shown. Perhaps this was an obvious choice, but it may be valuable to include these, at least in Fig 7, to understand the relative improvement for each of these scales. Also, in Figures 7,8 & 9 it is clear that the diurnal bias correction always results in a more negative bias than the standard bias correction. This is commented on in the text, but the authors do not provide possible explanation. Is the bias corrected precipitation consistently lower; the temperature and consequent evaporation consistently higher? I would assume this is the case, as if it simply a diurnal redistribution of moisture, then this may not be so consistently seen in the larger catchments. Please comment.

Line 342: I find the discussion on the errors in the tipping bucket somewhat suggestive. I agree that at very small rain rates the time of the tip may not well represent the time of precipitation, but I would hardly think this is a major contribution across all catchments and rainfall intensities in the datasets used here. Is there any research that substantiates this statement?

Line 371: A discussion is provided on the diurnal cycle due to evapotranspiration in the smaller catchments, with this being better represented after bias correction. I agree that this is may well be detectable in flow records for small catchments. However, when looking at figure 3 it would appear that there is a diurnal cycle in the temperature data. Indeed, the temperature in JJA has such a cycle but a clear positive bias, which one would expect would increase evapotranspiration further. Yet in Figure 10 there is no diurnal cycle at all in the unbiased simulations. This does seem somewhat incongruent. It may be good to explore this a little further. Overall Figure 10 can be improved in clarity also as it is not very clear.