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Discussions

Interactive comment on "Impact of downscaled rainfall biases on projected runoff changes" *by* Stephen P. Charles et al.

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I appreciate the valuable work done by the authors. The authors have analysed quantile-quantile matching approach of bias correction while using the WRF rainfall data (and characteristic data generated from the WRF data) and assessed their implications on hydrological projections in the Victoria state of Australia. The hydrological model (GR4J) setup was done at both lumped catchment scale and distributed 10 km grid scale. The results are interesting, however, I have a few questions regarding the methods.

General comments: The abstract is nicely written with a valuable conclusion, however, do you think the biases in runoff projection are also limited to the hydrological

model choice? More appropriately, can the biases be reduced by employing a semi- or fully-distributed hydrological models which account for land use, soil characteristics and sub-surface flows? This is because there are several existing studies which have validated that runoff predictions are not only limited to climatological data, but physical processes such as SW-GW interaction, vegetation cover etc. which GR4J does not count for. Based on your experience do you think if the bias correction (while using either QQM or linear scaling) of the GCM projections was done at station scale and used for the catchment scale (lumped) hydrological simulation would have reduced the bias in the results compared to the results presented (as wide range of results are observed for the four GCM projections) in your manuscript? This also follows based on the findings of Muerth et al. (2013) which you have discussed in Pg12 Ln15 as high biased climate signals propagate in hydrological simulations. Pg4 Ln 16: Can you please elaborate on the use of GCM data for only SRES A2 scenario? Also, as the SRES emission scenario data inherit more uncertainties over the RCP scenarios, is it valid for its use in this study as this paper deals with uncertainties cascading to hydrological simulations? This is because, in a study such as Woldemeskel et al. (2015), the uncertainty in precipitation for RCP scenarios of CMIP5 were significantly lower compared to SRES scenarios of CMIP3 GCMs in the Australian region. What do you think about this? Can you please write more on the calibration of GR4J at grid scale? As per my experience, GR4J accounts for the rainfall and PET to determine the effective precipitation and then the flow routing is done at catchment outlet. As per the description given, it is not clear how the model is set using the distributed method at 10 km grid size? My specific question is how the routing is done at 100 km2 grid? Also, how the calibration is done at 100 km2 grid?

Specific comments: Pg2Ln 20 and 21: Please be consistent with the use of "-" in BC WRF as in some places it is there and some places not. Same issue with the "BC-rainfall" and "BC rainfall". Please check. Pg3 Ln6: Typo "WFR" instead of "WRF". Pg3Ln 3-7: I understand there are several advantages of using the AWAP data, however, as per the study of Tozar et al. (2012), using gridded data (be it either AWAP or

SILO) always introduce artificiality (due to spatial and temporal interpolation) and alter the “realness”. This further cascades to hydrological simulations and leads to unrealistic results. Do you think using AWAP dataset is valid rather than using BoM gauges data for this study? Tozar C.R., Kiem, A.S., Verdon-Kidd, D.C., 2012. On the uncertainties associated with using gridded rainfall data as a proxy for observed. Hydrology and Earth System Sciences, 16, 1481-1499. Woldemeskel F.M., Sharma A., Sivakumar B., Mehrotra R., 2016. Quantification of precipitation and temperature uncertainties simulated by CMIP3 and CMIP5 models. Journal of Geophysical Research: Atmospheres, 121, 3-17. Can you please briefly write about the quantile-quantile mapping approach used in the study? It will be useful for the readers from non-climatological background. Pg5 Ln4: Can you please provide a list of all these 137 catchments in the supporting information? Can you also please provide the median and the percentile of the GR4J calibration parameters for both catchment scale and grid based calibration in the supporting information file? Pg5 Ln 23-24: Can you briefly mention the probable reasons for the better performance of the lumped approach over the distributed approach of GR4J calibration? Given that the catchments are flat (as majority of catchments in the SE Australian region are flat), a distributed approach should have yielded in better results (Deb 2019; Deb et al. 2019). Deb P., 2019. Modelling non-stationarity in rainfall-runoff relationships in Australian catchments. PhD Thesis, University of Newcastle, Australia. Deb P., Kiem A.S., Willgoose G., 2019. A linked surface water-groundwater modelling approach to more realistically simulate rainfall-runoff non-stationarity in semi-arid regions. Journal of Hydrology, 575, 273-291. Are the runoff simulation results presented in sections 3.1 and 3.2 based on the distributed GR4J model setup? For the future plans (as mentioned in the conclusion), I would also recommend the use of a physical-process based semi-distributed (if not fully distributed) hydrological model for the future hydrological predictions.

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