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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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The manuscript presents a comprehensive comparison of various rainfall input to a hydrologic model in order to assess the impact of bias correction to RCM rainfall simulations from four different GCMs. The study was conducted in Victoria Australia and the hydrologic impact of the bias correction was assessed by looking at simulated runoff from 10 catchments. Quantifying the impact of bias correction on climate projection analyses is definitely an important research topic.

Main Comments: This is a regional study that is carried in Victoria Australia and therefore it is likely dependent on the modeling framework and the region's characteristics.

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Discussion paper

Thus, beyond the overall educational value that the readers who are not familiar with the region may gain, in order to appreciate the results and understand their applicability to other regions, the authors should describe in much more details the relevant regional hydrological characteristics, some differences among the selected catchments, the region's climate, and review the projected climatic change. The current version provides very little information on the study region.

The authors use QQM procedure to bias correct the WRF rainfall [BC-WRF]. A description of the procedure is missing and even the seasons that were used for the correction are not specified. The authors claim in a few places that the BC time series underestimate the daily wet-wet transition. Using the QQM procedure should only correct the magnitude of the [daily] rainfall events. Therefore, the dry-wet transitions of the rainfall from the raw WRF should not be different in the bias corrected rainfall. In addition, the spatial correlation of the BC-WRF, which is found to be different than the observed, is also should not be different than the raw WRF. These uncertainties in the rainfall sequencing and spatial correlation are likely originated from the GCMs and RCM and not from the bias correction procedure.

The four GCMs that were selected for this study should be validated with respect to their historic rainfall simulations . Their representation of the regional climatology in time and space should be evaluated. The raw GCMs should also be compared to analyze their projected climate change signal. The VERY large biases (hundreds of mm) of the raw-WRF (Fig 2) raise suspicion that the model may not capture the climatological features of the region. As for the GCMs evaluation, the raw-WRF simulations also have to be assessed in time and space to verify that it gets the seasonality and the expected spatial distribution. The authors may decide to remove the simulations GCMs and raw-WRF simulations that do not capture basic climatological features.

In Figure 8 the percent of the projected change in the runoff is presented. This analysis could be augmented by showing the transition of the percent change from the GCM, raw-WRF, BC-WRF, raw runoff and BC runoff. In the current analysis, the differences in changes are mainly attributed to the selection of the GCM, and the contribution of the BC is unclear

The hydrologic model that is used in this study (equations are not given) has 4-parameters. However, only one parameter (x1) the soil moisture storage represents the rainfall-landsurface interaction. The three other parameters control the routing. Therefore, in annual time scale and from mass balance perspective the most sensitive parameter should be x1. The use of such a simple hydrologic model can be an advantage because it is possible to conduct a sensitivity analysis to assess the dependency of the BC on the soil parameters. Thus, the contribution of the model to the impact of BC can be assessed.

A recent relevant publication that evaluates the uncertainty in WRF dynamic downscaling to water resources application:

Shamir E., E. Halper, T. Modrick, K. P. Georgakakos, H-I. Chang, T. M. Lahmer, C. Castro. 2019. Statistical and dynamical downscaling impact on projected hydrologic assessment in arid environment: A case study from Bill Williams River basin and Alamo Lake, Arizona": https://www.sciencedirect.com/science/article/pii/S2589915519300033

Minor comments The title is misleading: I recommend to revise the title to: 'Impact of bias corrected downscaled rainfall on projected future runoff'. The current title assumes that there are biases and it is not clear if the biases stem from the GCMs or RCM.

Unit of grid cells should be either 10x10 km or 10 km2, not 10 km. This should be fixed throughout the manuscript

'underestimation biases in wet-wet transition probabilities' See my comment above that probability matching does not correct for transition. In addition, the underestimation is not of the 'probabilities'. Maybe you meant to say that it underestimate the wet-wet transition occurrences.

Describe the emission scenario that was selected for this study ‘SRES A2’ is insufficient description.

The selection of 2060-2079 as the period for analysis of projected change is untraditional. Eqn 1 presents an uncommonly used objective function. The authors should discuss the reasons to select it and what hydrologic features this function emphasizes

The statement ‘The lumped modelling generally produced a slightly better calibration than the distributed modelling (Andréassian et al., 2004)’ seems like a general statement. It will be interesting to state the results of your comparison between the two approaches.

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