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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Uncertainty in runoff based on Global Climate Model precipitation and temperature data – Part 2: Estimation and uncertainty of annual runoff and reservoir yield" *by* M. C. Peel et al.

Anonymous Referee #1

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The article by Peel et al. mainly assesses the 'within-GCM' uncertainty and its impact on modelled runoff for climate change impact studies. Overall, the article is clearly structured and well written. However, I have major concerns about the very premise of the paper and the methods used by the authors. Therefore I seriously doubt it could be a valuable contribution to the journal Hydrology and Earth System Sciences.

Comments related to individual chapters:

TITLE:

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Interactive Discussion
Discussion Paper

The title is ambiguous and does not provide a proper summary of the article.

INTRODUCTION:

The introduction describes concisely the aim of the work and provides a clear overview of the study setup. However, previous studies on investigating and quantifying uncertainty from various sources other than GCMs are not referenced.

METHODOLOGY AND RELATED LITERATURE:

Section 2.1

The paper claims that the primary aim of this study is to investigate within-GCM uncertainty, but actually what it does is to approximate stochastic replicates of GCM runs based on a single run. The underlying assumption here is that various runs from one GCM have same long-term trend and low frequency signals, which is not necessarily true. The authors admit that this approximation represents an under-estimate of the true within-GCM uncertainty. This could be true. In fact the uncertainty within GCM is most likely to be GCM specific since GCMs have different sensitivity to initial conditions. Further, the initial condition is not the only difference between GCM runs. Some of the runs used different forcing (e.g. UKMO-HadGEM1 20C3M runs), some of the runs were simply run on different platforms (e.g. ECHO-G 20C3M runs). Therefore the approximation here can not represent the true within-GCM uncertainty. What really assessed in this study is the uncertainty within the stochastically generated data. There are CMIP3 GCMs that provide as many as 8 runs and more for CMIP5 GCMs. It would be much creditable if they use 3 to 10 real GCM runs to quantify within-GCM uncertainty rather than using 100 stochastically constructed replicates. Or at the very least, using those real GCM runs to validate the results and conclusion reached by using this method.

Section 2.4

Another serious problem with the methodology is how the GCM climate is related to

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catchment hydrology. Only 5 of the 17 catchments used in this study are larger than a grid cell of the finest-resolution GCM (MPI) out of the 5 GCMs investigated. Many catchments are smaller than one tenth of a grid cell. However, regardless of their size, an area weighted average of the GCM data based on the proportion of catchment area associated with each GCM grid cell are calculated for each catchment and used as input to hydrological model PERM after bias correction. As stated in the paper, the GCMs tend to over-estimate low MAP and under-estimate high MAP. Further averaging could only accentuate this. In worst case, a climate series averaged for an area hundreds of times larger than the catchment is forced to represent the catchment climate. This is beyond what a quantile-quantile bias correction can fix. The use of bias correction itself is problematic as it impairs the advantages of GCMs by altering spatiotemporal field consistency, relations among variables and by violating conservation principles (Ehret et al. 2012).

RESULTS AND DISCUSSION

The boxplots in Figures 4, 8 and 11 show that the within-GCM ranges are usually larger than the between-GCM (raw) ranges. This is to say that the initial condition used by a GCM has greater impact than the model structure and parametrisation. I suspect this is strongly related to the method used in this study.

CONCLUSIONS AND IMPLICATIONS

The authors conclude that the with-in GCM should not be neglected and has significant implications for interpreting climate change impact assessments and warned the decision makers the risk of sense of certainty that is unjustified. In reality, the large uncertainty in climate change impact assessments is well known, and it is also well established that the largest uncertainty is usually associated with GCM simulations. There are extensive discussions around how to improve this situation, including clearer communication, using multi-model ensembles, and eventually, improving models themselves. In my opinion, this paper adds limited value to the research community.

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References

Ehret, U., Zehe, E., Wulfmeyer, V., Warrach-Sagi, K., Liebert, J., 2012. HESS Opinions "Should we apply bias correction to global and regional climate model data?". Hydrol. Earth Syst. Sci., 16(9), 3391-3404, doi:10.5194/hess-16-3391-2012.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 4579, 2014.