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Hydrology and Earth System Sciences
Discussions

Interactive comment on "A simple tool for refining GCM water availability projections, applied to Chinese catchments" *by* Joe M. Osborne and F. Hugo Lambert

Anonymous Referee #1

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The authors propose an approach to refine future projections of Q by using simulated aridity and biased corrections via the Budyko framework. They aim to generate Q projections that are much better than Q data derived from direct GCM projections. Using the Budyko framework to refine Q data and correct biases seems like an interesting idea. However, I think that several big questions remain regarding the methodology and that need to be answered before the article can be published. The authors have made an effort in trying to explain extensively the calculations performed, however, this has been done in a way that is hard for the reader to understand. Also, I could not understand the relation of the methods with the "bias-correction" that the authors want to apply.

I have several questions:

1. The term "biased correction" is not defined thoroughly in the study. I read the article but I could not relate the biased calculations with the methodology described by the authors. It was just hard to follow. A proper explanation of what specific "biases" are the author trying to correct is missing. For instance, are the authors trying to correct the CMIP5 Q data with a Budyko-type equation (Eq. 2). If this is it, I do not understand why are there using so many ways of calculating Q and related changes (climate, human, GCM-LSM, Qa, Qh, below combined) in the context of this study. Please explain this clearly.

Also regarding what I just mentioned, if the authors are trying to perform this bias correction of CMIP5 data, I must say that I have a feeling that CMIP5 data for Q is already biased-corrected. For bias corrected I mean that it is made at least consistent in Budyko space (0<ET/P<1 and PET/P>0 and PET/P>ET/P) for most basins in the world. Strangely, the direct CMIP5 ET data does not comply with this (all over Budyko space), and hence I assume there has been some type of "bias correction" in this sense for CMIP5 Q data. The authors should check Q and ET data from CMIP5 data for their two basins and if so, please update.

2. The authors describe the methods partly in the introduction, partly under "Data" and partly under "methods". This was confusing, and hard to follow in general. I would describe the methodology in chronological order and only under "Methods". In this way, you would also clear much needed space to expand the literature review which is now limited. Please mention the several studies that use the Budyko framework to understand water changes in Chinese basins. I mention here a few. The authors say that there is "little consensus on the contributions of these two components to the decrease in Q". I would say that there is plenty, mainly afforestation and/or flow regulation. And what is the Qh have to do with the bias correction. Again, please expand on this.

These Budyko-China basins studies could be included.

âĂć Fang, J., Chen, A., Peng, C., Zhao, S. and Ci, L.: Changes in Forest Biomass Carbon Storage in China Between 1949 and 1998, Science, 292(5525), 2320–2322, doi:10.1126/science.1058629, 2001.

âĂć Huang, M., Zhang, L. and Gallichand, J.: Runoff responses to afforestation in a watershed of the Loess Plateau, China, Hydrol. Process., 17(13), 2599–2609, doi:10.1002/hyp.1281, 2003.

âĂć Jaramillo, F. and Destouni, G.: Local flow regulation and irrigation raise global human water consumption and footprint, Science, 350(6265), 1248–1251, doi:10.1126/science.aad1010, 2015.

âĂć Liu, M., Tian, H., Chen, G., Ren, W., Zhang, C. and Liu, J.: Effects of Land-Use and Land-Cover Change on Evapotranspiration and Water Yield in China During 1900-20001, JAWRA Journal of the American Water Resources Association, 44(5), 1193–1207, doi:10.1111/j.1752-1688.2008.00243.x, 2008.

âĂć Qiu, G. Y., Yin, J., Tian, F. and Geng, S.: Effects of the “Conversion of Cropland to Forest and Grassland Program” on the Water Budget of the Jinghe River Catchment in China, J. Environ. Qual., 40(6), 1745–1755, doi:10.2134/jeq2010.0263, 2011.

âĂć Xu, X., Yang, D., Yang, H. and Lei, H.: Attribution analysis based on the Budyko hypothesis for detecting the dominant cause of runoff decline in Haihe basin, Journal of Hydrology, 510, 530–540, doi:10.1016/j.jhydrol.2013.12.052, 2014.

âĂć Zhang, X., Zhang, L., Zhao, J., Rustomji, P. and Hairsine, P.: Responses of stream-flow to changes in climate and land use/cover in the Loess Plateau, China, Water Resour. Res., 44(7), W00A07, doi:10.1029/2007WR006711, 2008.

3. I tried to understand the methods:

a. You calculate historical Q from GRDC data (1951-2000)

b. You calculate E as P-Q from a) (1951-2000)

c. You calculate Ep from Penman-Monteith (1951-2000)

d. You calculate Q from LPJ-LSM (1951-2000). Here I could not understand what is this estimate trying to represent? Is it land-use driven Q, climatic Q, combined Q, or what? It was hard to follow, the explanation of the multiple runs.

e. You calculate Q from the CMIP5 data (2006-2100) as P-E. Here see my comment 1, specially regarding the statement of line 31 Page 5, “Conclusions should. . .”

f. You calculate Ep from the CMIP5 data (2006-2100)

g. Calibrate Eq. 2 to obtain w. How did you do that? I would do it as:

*Wang, D. and Hejazi, M.: Quantifying the relative contribution of the climate and direct human impacts on mean annual streamflow in the contiguous United States, Water Resources Research, 47(10), n/a–n/a, doi:10.1029/2010WR010283, 2011.

h. You calculate Qa

i. You calculate Qh, I could not understand why nor how. What does Qh have to do with the biased correction?

j. Now you calculate changes in all Q components.

k. Then you compare Qa with Q from LPJ LSM. Again, it is hard to know what this comparison should result in, since it is not clear what Q from LPJ LSM really represent.

l. I got lost in what Q* psychically means. If this is the main purpose of the study, then I cannot understand why the authors go through a to k.

The authors need to mention what calculations are related with the bias-correction, and which ones are related with the aim of calculating the human component of Q (Qh). So, is this the chronological order of calculations? If not, please modify. Also, where is the correction bias coming into these methods, I could not see it, until maybe

the calculation of Q*. Please specify.

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