

Interactive comment on “Responses of runoff to historical and future climate variability over China” by Chuanhao Wu et al.

Anonymous Referee #2

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This paper applies Budyko's concept of 'climate elasticity' in the response of runoff to changes in precipitation, potential evapotranspiration and catchment properties to projections of climate change from an ensemble of general circulation model projections. The authors use this to assess the robustness of projections of changes in future due to climate change in different regions of China.

Climate elasticity concept seems quite neat for the question of responses to climate change (separating P and PET drivers, and also with the potential for accounting for other drivers via the catchment properties) and in my opinion the authors have applied this appropriately to the specific question of responses to an ensemble of climate change projections. I would however advise more care in the interpretation, as these should not be taken as actual predictions of the future (which the language used some-

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times suggests that there are). There are 3 reasons for this:

(1) While the use of the multi-model ensemble probably is a good, well-established way to explore a number of possible outcomes, the ensemble is not designed to be probabilistic, ie: it is not intended to give an indication of likelihoods. It is an 'ensemble of opportunity', using all models that happened to be available in the community, and the levels of skill for regional climate change in China will vary somewhat arbitrarily. The models themselves have not been specifically chosen or varied in order to systematically explore regional climate changes. Likelihood statements generally require further backing-up with understanding of model performance and the simulated climate processes in the region in question. Therefore I would encourage the authors to avoid terms such as "climate change will likely cause an obvious increase (decrease) of R" – the simulations are not intended to give guidance on likelihoods. (2) It is also not clear to me whether the catchment properties term includes plant stomatal responses to CO₂. (It could do in theory). Two recent papers (Milly and Dunne, 2016, Nature Climate Change, and Swann et al, 2016, PNAS) showed that projected runoff changes in the GCMs tend to show a greater increase or smaller decrease in runoff than many hydrological models, because the GCM land surface schemes tend to include this term whereas hydrological models do not. It is not clear whether the VIC model includes this here or not. (3) The method used here does not, I believe, include other drivers of hydrological change eg. Land cover change, groundwater and river water extraction, irrigation etc. I think that in theory the catchment properties quantity could account for this, but it has not been applied to this here. We cannot assume that climate change is the only driver of hydrological change, and hence the interpretation of the results should bear this in mind.

The authors do acknowledge some of these issues to some extent at the end of the paper, but this is after the earlier discussion which often uses language of prediction, which I think goes too far. I would suggest terms such as "Climate change is projected to cause an increase (decrease) in R. . . ." Also I suggest the authors address the above

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points in more detail, highlighting the limits to the interpretation of the CMIP5 ensemble in terms of likelihoods.

My other concern is why the authors chose to use the Thornthwaite method for PET. It is stated on page 14 line 4 that this is because there is a “lack of meteorological data (such as relative humidity) in the GCM data. This is not true – GCMs are meteorological models, and indeed some of the CMIP5 GCMs are used in slightly different variants for numerical weather prediction. A huge range of meteorological outputs is available, including RH – see here http://cmip-pcmdi.llnl.gov/cmip5/docs/standard_output.pdf

I recommend that the authors use the data portal http://cmip-pcmdi.llnl.gov/cmip5/data_description.html at PCMDI, who organised CMIP5. The Canadian Climate Centre webpage used by the authors only has a very limited number of variables.

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