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Interactive comment on "Simulating human impacts on global water resources using VIC-5" *by* Bram Droppers et al.

Anonymous Referee #1

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General comments

The authors incorporated several water management components, namely, reservoir operation and water requirement estimation for irrigation, livestock, manufacturing, thermal powerplant cooling, domestic use, and environmental flow into the VIC-5 global hydrological model. They compared their simulation results with those of other similar models.

I think this manuscript is excellently written as a model description paper. As for the model itself, however, I feel it includes too few novel aspects. The global offline simulation of VIC was first conducted about 20 years ago (Nijssen et al. 2001). Reservoir operation and irrigation were first introduced in VIC about 15 years ago (Haddeland et al. 2006). The water management components incorporated in this study are mostly

taken from earlier studies (e.g. Alcamo et al. 2003; Hanasaki et al. 2006; Pastor et al. 2014). I understand that this journal does not necessarily require concrete scientific advances, but I personally think that this paper would become better if the authors further emphasize the originality and strength. It is also strongly recommended to provide more concrete information on the capability of this model. In particular, the simulation results should be more rigorously compared with observation, not simulation results of other models.

Specific comments

Line 54 "Several models do not yet incorporate all aspects of anthropogenic water withdrawals…": Some models include 'most' of them already (Döll et al., 2014; Wada et al., 2014; Hanasaki et al., 2018). What is the point here?

Line 89-95: Over all, I feel that the motivation of this study is not well expressed. The present form only tells that the authors want to develop a water resources model based on VIC-5. Perhaps the authors were motivated to integrate the past major works on water management and upgrade the entire model. If this is the case, the model description paper of PCR-GLOBWB2 (Sutanudjaja et al. 2018) provides a good example how to write this part.

Line 227 "Irrigation demands": Does this model support multiple cropping? This point is worth mentioning since it substantially influences irrigation water estimates in Asia, and eventually the globe.

Line 238 "who estimated the irrigation efficiency for 22 United Nations sub-regions based on differences between calculated irrigation requirements and reported irrigation withdrawals": Taking at face value, any calculated requirements will perfectly match with reported withdrawals by this method, which sounds a bit odd. Anyway, irrigation efficiency is quite sensitive to the results and performance, please elaborate the background and concept.

Line 314 "The VIC-WUR model results were compared to several of the ISIMIP simulation round 2a global hydrological impact models": I think VIC-WUR model should be first compared with observation more rigorously. For instance, the simulated river discharge, terrestrial storage components, and reservoir components should be compared with river gauge, terrestrial water storage of the GRACE satellite estimation, and in-situ reservoir operation records, respectively (e.g. Döll et al. 2014; Hanasaki et al. 2018). All the model simulations contain error, hence model-model comparison is not helpful to understand the strength and capability of VIC-WUR.

Line 334 "while the ensemble mean potential and actual withdrawals were only 2200km3 and 1400km3 respectively": According to Figure 3, the potential withdrawal looks more than 2200 km3. Please revisit the number (or figure).

Figure 5: First, domestic water withdrawal of the H08 model is an apparent outlier. It would only make sense if the model reports water consumption, not water withdrawal. Anyway, this figure only tells us that all the models and estimates are different. It doesn't provide any concrete information how well the performance of VIC-WUR is.

Line 400 "Actual irrigation withdrawals of VIC-WUR are high compared to the other models…": The 'actual irrigation withdrawals' simulated by global hydrological models are highly dependent on the model components (e.g. groundwater, small irrigation reservoir, aqueducts, etc.) and the settings (e.g. calculation interval, assignment of environmental flow, etc.). Superficial comparison of numbers is simply meaningless. If the authors wish to keep this part, intensively discuss what can (and cannot) be learned from this intercomparison.

Line 420-434 "When adhering to EFRs the global water withdrawals are reduced substantially…": It is hard for me to support the claim here. The Environmental Flow Requirement (EFR) is, unfortunately, seldom taken care in water scarce regions. If it was taken care, we would observe no groundwater depletion, no terminal lake shrinkage, no flow depletion at river mouth at any places in the world. In reality, we do

observe such 'tragedy' at many places in the world (e.g. the groundwater depletion in the Central Valley in USA, the shrinkage of the Aral Sea, almost complete depletion at the river mouth of the Colorado River). I feel that EFR brings only uncertainties in the phase of model validation, hence better to put aside in a model description paper.

Line 436-448 "However, there are some challenges when applying the methods as described in our paper to future water-food-energy nexus assessments": I am not totally sure whether this paragraph is necessary in this paper. Indeed, the nexus has been extensively studied in the last decade, and some studies have already addressed some of the questions the authors raised. For instance, the community of integrated assessment models have studied on water scarcity on energy generation and manufacturing (Hejazi et al. 2014; Fujimori et al., 2017; Bijl et al. 2018).

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