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Hydrology and Earth System Sciences Discussions

Interactive comment on "Integrated assessment of global water scarcity over the 21st century – Part 1: Global water supply and demand under extreme radiative forcing" *by* M. I. Hejazi et al.

Anonymous Referee #1

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This paper developed an integrated water demand and water availability model where the climate change and water demand projections are based on the same socio-economic development. This is interesting and important since water demand and availability projections are usually conducted separately. This integrated model reflects the interconnection of socio-economics, water demand, and climate. I have some questions which need to be clarified.

Line 10 page 3329: "integrated assessment model of energy, agriculture, and climate (GCAM)". Add references for GCAM?

Line 27 page 3329: "Furthermore, any quantification of climate change impacts on

water resources is incomplete without also incorporating human demands of water. . ." Why? Should be "..climate change impacts on water stress. . ."? Line 14 page 3330: "Oki et al. (2001,1999)" to "Oki et al. (1999,2000)" Lines 14-19 page 3330: are these models implemented in GCMs? Otherwise, "incorporated" in line 7 needs to be changed (to "coupled"?). Lines 22-28 page 3330: What are the differences between this group of water balance model and the hydrologic models in the previous paragraph? Model structure or the way of coupling with GCMs? Lines 10-11 page 3331: "soil water content thresholds are set at which irrigation is triggered". Are "soil water content thresholds" the lower bounds of soil water content? Not clear.

Lines 1-12 page 3333: The GCAM model is described briefly in this section. It seems that the GCAM model includes the component of climate model (Figure 1). Are precipitation and temperature projections up to 2095 generated by the component of "Climate System"? If this is the case, what's the time step for projected rainfall and temperature? If it is monthly, please clarify "runs in five-year time steps" (line 5 page 3333). GCAM is like an integrated climate and socio-economic model.

Lines 18-23 page 3333: There is no river routing in the hydrologic model. Please add some discussions on its impact on monthly runoff at the spatial resolution of 0.5 degree. The missing of river and reservoir routing may be important at the monthly scale.

Line 3 page 3334: specify the time period of "historical streamflow observations". Line 16 page 3334: what's the water scarcity indices of Falkenmark (1989) and Raskin (1997)? Lines 27-28 page 3334: "a gridded monthly water balance model with a resolution of 0.5×0.5âŮę" which repeats the previous sentence. Line 1 page 3335: "maximum soil water storage capacity (a function of land cover). . .". But in lines 10-11 page 3335, "The maximum soil moisture storage capacity . . .... and soil properties. . .". The computation of Sm, which is a very important parameter for your monthly water balance model, is described Lines 11-17. This part should be described with more details, such as Sm= root depth *(field capacity-wilting point value)? How are root depths

computed?

Figure 2: It is difficult to read the numbers in the legend. If the purpose is only to present the model structure, the diagram is not quite informative since it only shows the inputs and outputs of the monthly water balance model.

"...renewable water resources (i.e., annual flow of rivers and recharge of aquifers)..." How is recharge of aquifers computed? No description of the recharge in the description of model structure such as Figure 2 and equation (1). Lines 25-26 page 3335: "...the amount of water available (St−1+Pt−PETt)..." It is not clear for me that PETt is used here for defining available water. Lines 17-18 page 3337: "...from the Tyndall Centre for Climate Change Re- search (TYN SC 2.1, Mitchell and Jones, 2005)..." Are the monthly climatic inputs in the future taken from TYN SC 2.1? Is TYN SC a component of GCAM? If not, how the interaction and feedback between human water use and socio-economic and climate systems are quantified in the GCAM? Lines 5-15 page 3338: The difference of estimation methods may also contribute to the difference of runoff estimation. Lines 17-20 page 3339: it seems that rainfall and temperature based on GCM are feed into the developed hydrologic model. Then how is the socio-economic feedback to water availability shown in Figure 1 is included in the modeling framework? Lines 21-23 page 3340: "In this study, socioeconomic characteristics and emissions prices are adjusted so that the GCAM output for radiative forcing matches that associated with the SRES A1Fi emission scenario....". This is important. The socio-economic scenario of water demand matches the emission scenario of climate change. I think this is the strength of the integrated model of this paper. Lines 22-23 page 3341: "...Assuming that population density maps remain static over time within each GCAM region..." not clear. Why does population density remain static with the increase of population? Line 12 page 3343: How to quantify "total water availability (TWA)" in the developed hydrologic model? Mean annual runoff? Is the future water demand projected by the population growth? The virtual water by goods trade such as food can mitigate the water scarcity regionally. This may be included in the discussion.

The length of the paper may be reduced. From example, the number of figures can be reduced.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 3327, 2013.