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Interactive comment on "Development and calibration of a global hydrological model for integrated assessment modeling" *by* Tingju Zhu et al.

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Comments: Given the length of time it is taking to secure a second review and given the positive nature of the first and my own initial impression of the manuscript, I have decided to move to a decision with one review along with another direct from myself as handling editor.

Response: We appreciate the handling editor for conducting the review of this manuscript.

Comments: The paper is generally very well written with very few typos, I did not pick

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out any further to those already pointed out by the reviewer- except a question as to what is meant by the mm/a units for runoff – mm/year I assume? Please replace with something clearer. There is a pressing need for computationally efficient models with this level of process detail and spatial representation to aid impact assessment and scenario analysis, so I concur this is a worthy contribution.

Response: Thanks for pointing this out. The runoff unit mm/a represents mm/year. We thank the handling editor for the positive comment on the need for computational efficient models.

Changes in manuscript: On page 13, in the title of Figure 2, we have changed the runoff unit to “mm/year.”

Comments: The extreme negative values (-3000 for IGHM and >9000 for WGHM) in Figure 2 are concerning – can you explain these? And discuss a little more the issues that might happen when you have a combination of open water and terrestrial land within a grid, particularly in arid conditions; lack of lateral transfers might be causing some artefacts here. It would be much preferable to split Figure 2 into one which gives the actual runoff values rather than runoff- evap, and additionally show the evap as an additional figure.

Response: The extreme negative numbers (e.g. <-500 mm/year) in WGHM arise in few grid cells and are results of the calculation of large water bodies (located in dry regions where potential evapotranspiration PET is larger than precipitation P) in their outflow grid cell. Negative runoff values in WGHM indicate that inflowing water from upstream evaporates in lakes and wetlands in which the difference between PET and P exceeds local runoff production in the grid cell itself (e.g. Sudd Swamps). Similar patterns were found in the runoff values of IGHM. We decided to modify the legend text of the maps and now avoid showing those extreme high and low values to not confuse the readers. With regard to open water and terrestrial land coexisting in a grid, the IGHM and WGHM models calculate average evaporation of the grid using open

water evaporation value and land evapotranspiration value weighted by the fractions of open water and terrestrial land areas within the grid cell. The IGHM model does not include lateral transfers, while lateral water flows are simulated in the WGHM model at daily time intervals. In the IGHM model, runoff generated over open water equals rainfall subtracted by potential evaporation. The absence of lateral flow processes in the IGHM may lead to over- (e.g. when inflow exceeds outflow and lake area expands) or under-estimation (e.g. when inflow is less than outflow and lake area shrinks) of actual evaporation in open water areas. With regard to Figure 2, it does show runoff, not runoff minus evapotranspiration. We agree that it is a good idea to show evapotranspiration, too. Actual evapotranspiration of IGHM and WGHM are shown in Figure 2b, and runoff maps are shown in Figure 2a.

Changes in manuscript: We now use Figure 2a to show natural runoff and Figure 2b to show actual evaporation values in the paper. In addition, we added the following paragraph in Section 3.1: "Lateral water flows are simulated in the WGHM model at daily time intervals, whereas the IGHM model does not include lateral transfers. The absence of lateral flow processes in the IGHM may lead to over-estimation of actual evaporation if an open water area shrinks, or underestimation if it expands. In Figure 2, the large negative runoff values in WGHM arise in relatively few grid cells and are results of the calculation of large water bodies located in dry regions where potential evapotranspiration is larger than precipitation. There are generally more negative runoff grid cells in the IGHM runoff map due to fixed open water areas used in the IGHM database."

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