Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2020-235-RC2, 2020


Hydrology and Earth System Sciences
Discussions

# *Interactive comment on* "Uncertainty of simulated groundwater recharge at different global warming levels: A global-scale multi-model ensemble study" *by* Robert Reinecke et al.

**Anonymous Referee #2**

Received and published: 5 July 2020

The study presented by Reinecke et al. is based on a very important set of modeling, a very impressive work. The authors gather 8 Global Hydrological Model (GHM), 4 Global Climate Model (GCM),and 3 emission scenarios RCP. They address the uncertainty on the simulated groundwater recharge (GWR). Especially, an effort is made to estimate the uncertainty associated to the explicit account of dynamic vegetation. Especially, it was nice to aggregate the results according to global warming (GW) thresholds.
If the manuscript is of great interest, some parts of the analyzes are not clear. One of the main conclusions is that dynamic vegetation has a strong impact on the estimated GWR, which is far from being as obvious based on the results presented ... In addition,



some figures are difficult to read and seem to support only partially the comments.
You'll find below my mains remarks.

- Introduction: The choice is made to estimate ground water recharge throughout the continental part of the world. However, many areas have no extended groundwater. Whymap.org provides map of the extension of the aquifer. What does it mean to estimate GWR where there is no or local and shallows aquifer? Won't it be more interested to estimate the recharge on the aquifer domains?
- Line 200: It is necessary to provide information on the bias-adjusted method? What is the assumption? What is the reference climate used ?
- Section 2.1: I suggest to provide a table that summarizes if GHM includes or not in the GWR another part that a partition of the precipitation, especially, which GHM includes river to aquifer exchange, since this may be a very important difference in alluvial regions. Moreover, this table should also summarize which GHM integrates direct effect of CO2, explaining clearly if they account for stomatal aperture sensitivity to CO2 and/or for vegetation dynamic (LAI) (so far, this is not clear).
- Figure 2 is of bad quality... Is it necessary to have all the extremes? Is it reasonable to have a range over 2000mm/year? most aquifers recharge maps stop before 1000mm/year and often under 500. Are GWR values above 1500 in Figure 2 located in capacitive aquifers or in very local and shallow aquifer as defined by Whymap (see comment 1)? As this figure is difficult to read, it is impossible to check comments line 317-322
- Nice to disentangle the impact of GCM and GHM, but, fig3a includes 76 cases while fig b includes only 36 cases. How does this compare? In order to try to understand what the impact of GHM is, and what the impact of the response

of GHM to GW is, it seems required to show the variance of the 8 GHMs on preindustrial case. Figure 7 shows that there are important change, but, variance will be helpful to compare with fig3a.

- Figure 4 includes only one realization of one GHM and one GCM.... Why this GCM? Why this GHM? Is this GCM includes dynamic vegetation ? Is the dynamic vegetation of the GCM consistent with the one of the GHM? In any case, it would be nice to have some information on LAI changes...;
- Line 422 : Decrease of precipitation lead to a decrease of vegetation productivity $\Rightarrow$ I guess it is more complicated than that, you may correct
- Figure 5: is this figure correct? a same GHM can appear twice for a subregion with the same colors... A change of precipitation of 100mm/year can lead to an increase of GWR of the same amount... Is the vegetation dead ? It would be nice to better understand which process occurs in detail in one subregion ?
- Fig 6 compares 4 GHM with dynamic vegetation (change in LAI?) with the 4 others who assumes constant vegetation (but do they account sensitivity of the stomatal aperture to CO2?). The difference on the physics of the GHMs is large, but the impact seems reduced. How can we be sure that the difference is linked to the dynamic vegetation? Similar difference may well exist between this different GHMs without change in vegetation dynamic... Moreover, are the significant changes located where the aquifers are extended and capacitive, or where the aquifers are very shallow and local?
- Assessment of the GHM should not appear in the discussion.... It should be earlier, or in supplement... GWR estimates by Mohan is only the GWR from precipitation (no river inputs). How does this compare to the numerous GHM ?
- Line 539: “Despite the uncertainties, this study shows that climate change will



impact groundwater availability in many regions of the world”.: this is naïve: it was already shown by numerous regional studies....

- Line 545: “Moreover, this study shows that including dynamic vegetation processes in GHMs can change the results substantially”: this is not that clear from your results.... I was expected more impact indeed...

Other remarks:

- A map of the extension of the subdomain is required
- Numbering of figures is wrong
- Line 287: Masson-Delmotte et al...
- Figure S3 should be in the text since it is discussed

---

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2020-235, 2020.