A high resolution global scale groundwater model

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1. Scientific Significance: Does the manuscript represent a substantial contribution to scientific progress within the scope of Hydrology and Earth System Sciences (substantial new concepts, ideas, methods, or data)?

The study is good to excellent. The global simulation of groundwater flows is very interesting and potentially has important consequences; for example, countries trying to peacefully cope with boundary water issues may be able to use global models to achieve a plan with which all can live in peace. Model have played that role in many circumstances, such as the Klamath and Republican River basins in Oregon and Kansas, USA.

In this first of type study, clear presentation of methods is critical for the future utility of the work. The present study is mostly clear, though some things need additional explanation. Specific suggestions are provided below. A general comment is that the presentation of methods without reference to the figures, and reserving reference to the figures in the results section is does not work well. Using the figures to explain the methods and their consequences and saving the results and/or discussion section to discuss bigger consequences and possibly highlight briefly one situation for which the global model results are likely to be important would be much more interesting. Using a trans boundary water example seems like an obvious choice, but the authors may have other ideas. In this article the example would be quite superficial – just used existing figures to point out a situation of interest. One zoomed in figure might be useful as well.

2. Scientific Quality: Are the scientific approach and applied methods valid? Are the results discussed in an appropriate and balanced way (consideration of related work, including appropriate references)?

As far I as can tell the methods seem ok. Some are poorly enough explained that it is not possible to tell for sure.

3. Presentation Quality: Are the scientific results and conclusions presented in a clear, concise, and well-structured way (number and quality of figures/tables, appropriate use of English language)?

Clarification for some methods is required. Referring to the figures in the methods section and possibly including one or two small additional explanatory figures would help a great deal.

The following are more specific suggestions.

a) There are some typos. E.g. page 3 line 16. positivity. This same part of the text is repetitive. P. 4 first full paragraph is also repetitive.
b) Page 4, line 25. Not possible for f flowpath to be both simulated and actual. Remove “actual”.
c) Page 7.
    a. Line 1. There are 15 lithology classes in table 1. Expending should be expanding? This paragraph describes a situation much easier to understand if table 1 is referenced. You don’t need to talk about everything in a table or figure when it is first referenced.

b. Line 22. Item 1. First sentence. Does this sentence refer to elevations within on cell? This description is not clear.

d) Page 8. Item 2. How does the depth referred to compare to the thickness referred to on p. 9? Is this depth from land surface? Eq. for F'. What is the range for F'? Next page refers to a Gaussian distribution, so F' goes from minus to plus infinity? Does 0 to 50 apply everywhere? In general this is not clear.

e) Page 9. Item 3. How many studies were used? Two are mentioned. In this item is the thickness of the unconsolidated deposits from land surface or water table?

f) Page 10. Line 2. Validation is a loaded word. Be more specific, such as compare to head and flow data? Line 6. Transmissivities of sediment thicknesses or all? Refer to table 1 for the hydrolithologic classes.

g) Page 11. The recharge is corrected for changing cell sizes. It is not clear to me why conductances were also not corrected. There was a comment about a full K tensor being needed, but there is an intermediate correction method that could have at least accounted for the changing length of flow. Whatever you did is fine, but be clear.

h) P. 12. Line 2. "Factor" is too vague. At least cite the purpose of the factor.

i) Page 12. Line 13. There is no thickness of the riverbed allocated, although a a riverbed conductance is assigned, right. Again, no problem, but be clear.

j) Page 12. Eq. for Qriv suggests an original MODFLOW sign convention, while a previous discussion for pumpage suggested a reversed sign convention. Be clear about the model sign convension. If it differs within the model and in the input files, be very, very clear.

k) Page 12. Eq. 12. Pchn not defined.

l) Page 13. Line 2. What does "tortuosity here" mean? In general, clarify this description.

m) Page 13. Eq. 14. This equation is calculated on a cell-by-cell basis, right? Qriv and Qdrn are negative for flow out of the gw and into the sw, based on earlier descriptions. This is consistent with the MODFLOW convention. It there is flow out the drains and river, the first term of the equation is thus positive. Let's day the distance L is very large and T is small so the second term is small. This leaves a Qbj value that is a positive number equal to the absolute value of (Qriv + Qdrn). As a positive number the sign convention would suggest this is flow to the gw system. The argument behind the magnitude and the sign do not make any obvious sense at all. Please provide a rationale and simple example such as I used here to clarify what was done.

n) Page 14. In section 2.4 refer briefly to fig. 5. Discussing it later is fine, but being introduced at this point makes it a lot easier for the reader.

o) Page 14. This paragraph says in one place that gw depth is evaluated and then that heads are evaluated instead of depth. This is confusing. 65.303 cells are mentioned. How many are there in total.

p) Page 15. Refer to figures 6 and 7. What are "flux densities"?

q) Page 15. Line 21. Say the CVs are less than 1.0 instead of "small", which is vague.

r) Page 17. Should be Amazon.

s) Page 18. Lines 16-17. Spend a few sentences on examples of interbasin flows and how they are represented in the figures shown. Line 21. …systems exist AND no capture… Line 22. Odd to use this reference in this context.