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Hydrology and Earth System Sciences
Discussions

Interactive comment on "HESS Opinions: Improving the evaluation of groundwater representation in continental to global scale models" *by* Tom Gleeson et al.

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I understand the requirement to have improved groundwater modelling capability in earth system science but I am really not sure that this paper is advocating a correct strategy for achieving that. It starts from the viewpoint of a community of global groundwater modellers that there are global groundwater models available that need to be evaluated (with a view to improvement). As such it completely ignores the experience of what are here called the regional hydrogeologists in implementing operational groundwater models (with all their difficulties of conceptual models of the geology, spatial heterogeneities in transmissivities, fracturing, disconnections between layers and

local confinement, patterns of (sometimes unlicensed) abstractions, etc etc). There is, for example, no mention of the Danish National Water Resources Model that has tried to do this at a national scale (and even then run into scale, conceptualisation, and parameterisation problems).

So, in that groundwater is framed by local geology, which can vary at below the global groundwater model grid scale, it would seem to be much more productive if the approach to the global problem was to provide a portal to make use of that regional information much more directly than the portal for model evaluation suggested here (it is interesting that "geology" as such does not appear in the text – only in authors affiliations – we have to infer it from "conceptualisations"). There will, of course, be gaps in the global coverage where there are important groundwater bodies but where no regional or local models are available and data is poor. Certainly in those situations we would need to resort to expert elicitation in creating a suitable model to make the coverage more complete. But that is a different problem.

Because bringing in regional hydrogeologist expertise to evaluate the global modelling (as suggested) would seem to be doomed to failure. The global grid scale and variation in parameters is too crude. The generation of recharge rates and evapotranspiration rates when the water table is near the surface just cannot be properly represented when the grid scale cannot reflect the local variations in topography, but there is nothing here about evaluating such fluxes (and getting such boundary conditions right is surely rather important ….. Or is that being left to the global land surface modellers rather than the global groundwater modellers?). The paper recognises the issues of commensurability, but has no suggestion for how to take that into account (except for the use of "signatures" but it is then not explicit about how that might actually work). And some of the suggestions for "evaluation" seem to me to be rather circular (see comments on manuscript).

And then there is karst. This is rather important in some parts of the world. It does get just a passing mention in the text (through the paper of Hartmann et al., 2017) but

there is no discussion of how this might fit into a global model based on PDE continuum approaches.

The paper is the outcome of a workshop on global groundwater modelling but for all the expertise available it seems to me to be wrong about how to approach the problem (perhaps because the expertise of operational groundwater modellers was not that well represented). Evaluation of the type of global groundwater models being suggested is not really the issue. For all sorts of reasons we can expect that they will be too crude and too approximate and will not make best use of local information where that is available (even to the point of local rejection). Global groundwater is an aggregation of regional and local groundwater systems with all their different geological and other characteristics. If the problem of using that regional and local information directly is only computational, then ways could be found of simulating the responses more efficiently (not necessarily using a coarser grid, but, for example, perhaps using machine learning). Where a regional or local model cannot be used because of bureaucratic reasons, then it will be necessary to construct a simulator in the same way as for a data-sparse area, but again without data there can be no evaluation (the expert elicitation will already have been used in the construction).

I would suggest, therefore, that this paper needs more, and deeper thought, and should not necessarily have a starting point of here is global groundwater model how do we evaluate it, but rather here are all the important aquifers worth representing, how should their response be best represented (which might of course be locally/regionally a PDE continuum model – or not)?

There are many more comments on the manuscript

Keith Beven

Please also note the supplement to this comment:
https://hess.copernicus.org/preprints/hess-2020-378/hess-2020-378-RC1-

supplement.pdf

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