Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., author comment AC4
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Author Response on RC3

Danielle S. Grogan et al.

Author comment on "Water balance model (WBM) v.1.0.0: a scalable gridded global hydrologic model with water-tracking functionality" by Danielle S. Grogan et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2022-59-AC4, 2022

Reviewer #3

General comments

The paper describes the WBM global hydrological model in detail. WBM is one of the earliest global hydrological models which contributed to the establishing the field of global hydrology. This paper provides the full description of the model together with the development history which will be quite useful for the modeling community. In particular, the water source tracking function is novel and very interesting. The paper is well prepared and mostly very readable. I have only minor technical comments.

We would like to thank Reviewer #3 for their time in providing thoughtful comments on this paper.

Specific comments

Line 189 "Soil moisture balance calculations for natural landcovers are fully described in (Wisser et al., 2010a) and crop landcovers in (Grogan, 2016).": Better to show the essence here because soil moisture balance calculation is the most fundamental function of any hydrological models.

We can add a brief introduction of the soil moisture balance calculations that are present in the model's documentation in the main body of the manuscript. We have been reluctant to add to the length of the manuscript, and this functionality is well documented elsewhere; however, we do concur that it is fundamental to this hydrologic model.

Line 270 "PyGEM's standard output format is not gridded; rather, post-processed PyGEM output is required as input for WBM (Prusevich, et al., 2021).": How frequently is the glacier fraction updated (e.g. daily, monthly, annually)?

Thank you for catching that. Glacier water (glacier runoff) is updated at monthly timesteps in the model in accordance with the source PyGEM glacier point data. Some PyGEM variables such as glacier volume and area are updated at annual timesteps so WBM also updates those layers at the annual timestep. We can update the text to clarify details on glacier water input in any revision of the

manuscript.

Line 358 "Rather, they collect rainwater and surface runoff, storing it on the land surface and preventing it from reaching the rivers system": How are these processes formulated? What are the key inputs and parameters?

Greater detail regarding how these small reservoirs are handled is available in the technical documentation that we plan to include as a supplement to the manuscript if it is consistent with the Journal's practices.

Line 368 "WBM's inter-basin transfer methods were first developed and described in (Zaveri et al., 2016) and described again in (Liu et al., 2017).": Can this inter-basin transfer scheme be applied to global simulations? If so, how the parameters were set (i.e. is such information available)?

An IBT database was developed for specific publications (e.g. Zaveri et al., 2016), however a global version has not been released. This functionality is available to users if they develop tables representing inter-basin transfers with further details available in the technical documentation.

Line 400 "Stream water available for extraction is estimated as 80% of water retained in river and reservoir storage following routing during the previous time-step W^{k-1}, plus the volume, Vstream, represented by flow through the reach during the previous time-step:" A bit hard to read and associate with Equation 26. What is Vstream? Is this representing the available surface water?

We now see this sentence is confusing and we will rework it in an effort to make it clear. V_{stream} is the total volume potentially available for extraction from the prior time-step.

Line 621 "The global simulations described above used a grid cell resolution of 0.5 degrees.": This should be mentioned in the previous paragraph.

Yes, we will move the resolution to the previous paragraph.

Line 629 "These continental-scale simulations of India used the same 0.5 degree spatial resolution as the global simulations.": What were the input meteorological data used in these simulations? The performance of river discharge simulation is largely dependent on the quality of input meteorological data (e.g. Hanasaki et al. 2022, HESS).

The Zaveri et al (2016) paper used the Asia-specific APHRODITE climate drivers. We will amend the text to clarify this.

Line 721 "We also calculate the Index of Agreement, d, (Willmott, 1981)": Why was this indicator chosen? I recall that most of the earlier works used NSE.

For brevity, we selected a single efficiency measure, d, in addition to a measure of model bias. Several researchers have pointed out short-comings of any single efficiency measure including the Nash-Sutcliffe Efficiency (Krause et al. 2005, Knoben et al. 2019), which tends to be insufficiently sensitive to systematic biases. Still, in deference to this comment and other similar comments by other reviewers, we should amend our presentation with reports of additional efficiency measures, likely to include NSE and the Kling-Gupta Efficiency (Gupta et al. 2009).

Line 740 "Despite the global average good agreement, there is significant spatial

variability, with lower MBE values across much of South America and East Asia (Figs. 5c and 6c).”: When one looks at the absolute MBE, the performance of river discharge simulations in arid or semi-arid regions always appears to be "good" because the runoff is very small. This needs to be pointed out in the text.

Thank you for pointing this out. We will include this in the text. In addition, we are considering adding a relative bias metric that would highlight any issues with model misfit in arid and semi-arid regions.

Line 750 Figure 6: What is the difference between Figure 5 (c) and 6 (c)? Only the unit is different?

Yes, the figures are showing the difference between daily and monthly metrics as identified by both the units, and in the captions of the two figures. We include both as many researchers running global simulations use monthly outputs in their papers. We also include daily metrics as the model runs at this time step.

References:

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Zaveri, E., Grogan, D. S., Fisher-Vanden, K., Frolking, S., Lammers, R. B., Wrenn, D. H., Prusevich, A., and Nicholas, R. E.: Invisible water, visible impact: groundwater use and Indian agriculture under climate change, Environ. Res. Lett., 11, 084005, https://doi.org/10.1088/1748-9326/11/8/084005, 2016.