

Geosci. Model Dev. Discuss., author comment AC2
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Author Response on RC1 for gmd-2022-59

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-AC2>, 2022

Reviewer #1

We would like to thank Reviewer #1 for their very thorough commentary, and this has significantly improved the paper.

The model description paper of Grogan et al. describes an Open Source version of the model WBM. Overall, they provide a well-structured summary of the model. I like to also highlight the availability of data and model source code. However, I also think the manuscript requires some clarifications to be a helpful addition to the scientific community.

Foremost, the abstract and introduction provide no indication of why the model is relevant and how its result already has or will contribute to our scientific knowledge. It is also unclear how this model differs from the vast collection of other global hydrological models. What are the features that make it unique? Why should I be interested as a potential user and scientist to have a closer look? What are the current challenges?

Additional notes:

Previous GMD guidelines stated that the model version needs to be noted in the manuscript title. Please check if that is still the case.

You are correct, we will add the version number to the title.

11: what does long mean? Maybe instead, refer to the first published version in year X

We will make this change to clarify that WBM has a publication history since 1989.

12: So, the previous versions have not included it, and this is a new feature?

While the tracking features have been used in prior publications such as Grogan et al. 2017 and Zuidema et al. 2020, the tracking module has not been described generally until this publication.

14: I do not think it is necessary to refer to the GitHub link in the abstract. Please instead

describe what makes WBM unique and why it is useful. I am halfway into the abstract and still have no idea why I should care about the model

15: Remove unnecessary technical detail in the abstract.

16-17: Ok, so what have you learned? What is the model able to do? Why should I care as a scientist and possible user?

We will update the abstract to remove the GitHub link, reduce technical detail and expand upon what we learned, what the model can do, and why it is useful.

17 - 22: Ok, so this is really interesting, but the sentences are long. If this is a unique feature of this model, it should be stated. In what new ways can we perform experiments with that model that are not possible with other models? After reading only the abstract, it is still unclear why I should care about this model and how it has maybe already contributed to science and will continue to be of interest. What are the scientific questions that it is designed to answer or will enable us to answer in the future? How does it differ from other models? How well or bad does it perform overall / compared to other models? What is the spatial resolution?

The sentences do not appear to us to be overly long, but we will shorten if the Editor advises this. We will add to the abstract some content on what the model can do, its contribution, the ability to capture the hydrological cycle and the spatial resolution.

Introduction: I think you provide an excellent summary of what has been developed. However, I wonder if that should be condensed to a table instead. Half of the text is just references. Also, it would be nice to focus more on why we build these global models and what kind of questions they are supposed to answer, and what they can't do. There are obvious limitations, and people have been criticizing them a lot (sometimes fairly, sometimes not); because of that I think it is essential to highlight the ongoing discussion of what they are and what scientific insights we gained. And specifically, what the remaining challenges are - possibly hinting on your model? How is it different from all the literature that you are outlining?

We appreciate the reviewer's constructive feedback regarding the framing we present in the introduction. While we agree with many of these comments, we do not feel the text should be converted to a table as this does not represent a comprehensive and detailed review of GHMs. Putting it into a table may give that impression.

We will add to the introduction a paragraph discussing some recent model intercomparisons (GHMs with a focus on human processes) to address what they do well and do not do well. We will also include text on how WBM fits into the milieu of other GHMs. For example:

Many of the GHMs were developed to address questions at global and continental scales and these models have been designed to capture the macro-scale behavior of the water cycle in both the natural and human systems (Telteu et al., 2021). In an assessment of six GHMs Zaherpour et al., (2018) found these models did not perform well during low runoff periods and they tended to overestimate mean annual runoff and discharge. Veldkamp et al., (2018) evaluated five of those models and the inclusion of human impacts in these hydrological models greatly improved river discharge estimates and in most cases lowered estimates of river flow. The human influence on the hydrological system is still in need of development in GHMs and Wada et al., (2017) included

better representation of regional water management, co-evolution of the human-water system and improved human water management information as some of the areas to focus on for improvement in hydrological modeling. A large challenge for macro-scale hydrological modelers is to better capture the human decision-making around water movement, use, and consumption and one direction is via linking models from the social sciences to our hydrological models.

The model described in this paper, the Water Balance Model, captures all the major land surface water stocks and fluxes with a focus on human alterations of the water cycle. A significant contribution of this version model is the ability to track water depending on its source or use through the entirety of the system. When compared to global river discharge from similar GHMs, the WBM tends to fall within the range of these other models (Dai and Trenbeth, 2002, van Beek et al. 2011). The consistency with other models of global hydrology, with the addition of component tracking makes it possible to more deeply evaluate the generative processes that lead to the predicted hydrologic fluxes.

These are all questions that can be touched upon in the abstract.

Fig.1: This is very helpful. Could you add the timescales on which these fluxes and storages are simulated?

We will expand the caption to provide additional details including time scales.

Table 1: I think this can be moved to the supplement.

Yes, we agree that the table can be moved to the supplement.

199: This documentation should be appended as supplemental material or uploaded somewhere to provide a doi. If the GitHub repository is lost, this link is not really helpful. This is also the case in various other places in the manuscript.

Yes, we will include the GitHub documentation as part of the supplement (provided this falls within the journal's guidelines).

Fig3: The y-axis is different on the plots and thus confusing. Also, the quality does not seem to be high. Not much to see when zooming in.

We will adjust the figures to a common y-axis range and improve the resolution.

Please also add a comparison to other global models. If it performs worse, state why the model's unique features are still useful.

In response to reviewer's requests, we will be adding a new table to any revision of the manuscript similar to that of Table 6 that compares WBM discharge estimates to those of previous GHMs. Though this table is still in draft form, we note that WBM's estimate of global discharge is in line with other's estimate over the same time period: about 40,000 km³ yr⁻¹ exorheic discharge and 2,000 km³ yr⁻¹ endorheic discharge. These estimates are consistent with those of Sutanudjaja et al. (2018) over the same time period (2000 to 2010), and a bit higher than a variety of studies that modeled epochs between 1960 and 2000, which generally coalesced around 36,000 to 39,000 km³ yr⁻¹.

Further, I was expecting to see something like Fig 6 and 5 here. Maybe move Fig. 3 to the supplement and refer to the result section.

Figure 3 is part of a section (3.1) which summarizes a number of published evaluation studies using previous versions of WBM. The range of variation in climate drivers, which affect hydrological results, is well known and we do not feel this paper is the place to explore these issues.

Fig.4: Please refer to Table 6.

We will refer to Table 6 in the Fig 4 caption.

Table6: Please add the model name. Is that the absolute difference to the simulation that you are showing? Or the absolute value? The description text is confusing on this matter.

The values presented in Table 6 represent the absolute values of each study's estimate of global irrigation withdrawals. We will adjust the caption as we agree the wording is misleading. We will also add the model names to each row in the table where applicable.

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