

Geosci. Model Dev. Discuss., referee comment RC4  
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## Comment on gmd-2022-59

Anonymous Referee #4

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Referee 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-RC4>, 2022

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### General comments

The paper „WBA: A scalable gridded global hydrologic model with water tracking functionality“, by Grogan et al. provides a description of the first open source version of the University of New Hampshire Water Balance Model. The authors chose an approach that combines parts of a “classical” model description – i.e. description of the functionalities and fundamental equations, validation and a selection of case studies – with a literature review of the history of the model, previous studies with WBA and validation of previous model versions. Overall, this structure works really well and the paper is well written, thus, I only have a few minor suggestions.

### Minor comments

1) With respect to the model description, the authors did a very good job at providing a general overview over the basic equations and dependencies in the model without overloading the manuscript with technical details (which is perfectly reasonable given that most WBA components have been used in previous studies and have been well documented). However, it would be extremely helpful if the structure of the section 2.2 could be related to what is shown in figure 1, i.e. that all elements that are shown in the figure are discussed in the model description, preferably even in a way that each element in the figure has a subheading in the text.

2) I find the use of the term “unsustainable ground water” somewhat problematic, since it is not the groundwater itself that is unsustainable but its use e.g. for irrigation. A term

that clearly states either which real world pool is represented – e.g. fossil water – or what it constitutes in the model – namely an unlimited water supply to balance demand-supply mismatches – would be more appropriate. Maybe the authors could also add some discussion to section 2.2.2, detailing how the use of this pool affects simulations (especially projections) in regions where fossil ground water is being depleted.

3) I think it is a good idea to discuss existing model validation in this paper, rather than repeating the respective simulations with the present model version. However, it would be helpful if the authors could detail if and how the present model version differs to the model versions used in the previous studies and how these differences affect the results. Furthermore, with respect to the FrAMES model (component) I find the model validation a bit out of place here, as it is not merely a different version of WBA but a completely different model. I would expect the performance of the implemented functionalities to depend on many other aspects of the model and the forcing data, hence different simulated nitrogen concentrations with WBA. I think it would be sufficient to state, in the model description sec. 2.2.6, that WBA now includes these functionalities based on the parametrizations of the FrAMES model and reference the studies in which FrAMES was validated. However, I think it would be even better if the authors could actually perform the analysis and validate N and temperature in WBA simulations.

### Specific comments

Line 22: "... as well as perform model experiments in new ways". Please, clarify which are these new ways.

Lines 55 ff: Evapotranspiration will eventually lead to precipitation and a large fraction of the respective water is even recycled locally. Thus, the statement that only 50% of water is returned to "the system" is somewhat misleading. In contrast, when talking about specific pools in the system a 50% return rate is also often questionable, e.g. in case of fossil water, at least on a centennial timescale.

Fig. 1: Would it be possible to make the elements of the figure consistent with subheadings in section 2.2.? For example infiltration is not specifically discussed in the text.

Line 166: Eow is not defined.

Line 170: "Storm runoff" is this the same as "stormwater runoff"?

Line 179: What does WBA do in these grid cells e.g. in case of endorheic basins?

Line 183 f: Is this the only limit on infiltration? Is the state of the soil not taken into account?

Line 190: It may be helpful to mention that WBA does not have soil layers and does not explicitly represent the vertical flux through the soil or a soil moisture profile.

Line 257: How do you justify this default value of 1000 mm, i.e. that the model, in the default mode, has no real limit to the surface storage?

Line 280: I am a bit confused by the unit l/d is that per m<sup>2</sup>?

Line 490 ff & 503 ff: Is there a lag connected to the return flows?

Line 564: I am not familiar with the term "relic water", so I am not sure whether some definition is necessary.

Fig. 2: What is the meaning of the colors? Also why is the down-stream cycle different (no subheadings in "sources" and "water")?

Section 3.1: Could you maybe add a table for a quick overview?

Line 611: What about the UDEL climate? In Fig. 3 The R2 looked very promising?

Fig. 4: Maybe use the same axis for subfigure b and c?

Line 671: While I think it's a good way to use existing validation, I am not sure about the

FrAMES model, as the respective formulations lead to a very different outcome in the WBA framework?

Line 725: Could you also include R2 to make it easier to compare the present simulations to those in section 3.1 ?

Line 725: I would be very curious if you could also include an evaluation of the simulated evapotranspiration ... maybe against GLEAM data?

Fig. 5 & 6: Why is there no Index for the Nile/Indus/Ganges in subfigure c ? Also, would a relative measure make more sense than MBE.

Fig. 8 & 9: Could you do such a figure also for evapotranspiration?

Fig. 10: I find the purple and blue colors are very similar, and I am not sure that its only an issue related to my printer.

Line 906 ff: "... published in (Vörösmarty et al., 1989)". I would not use the brackets here.