

## ***Interactive comment on “Solver for Hydrologic Unstructured Domain (SHUD): Numerical modeling of watershed hydrology with the finite volume method” by Lele Shu et al.***

### **Anonymous Referee #1**

Received and published: 27 February 2020

The paper documents the SHUD hydrological model, which is a successor to PIHM (Penn State Integrated Hydrologic Model) first published in 2004. The paper describes the conceptual structure of the model and the mathematical equations behind the different process modules, and it then presents three test cases. The paper is well written, the model components are clearly presented, and the test cases adequately highlight some of the important features of the model.

Some specific comments and suggestions follow.

It is not until well into the paper (section 4.1) that we learn what distinguishes SHUD from PIHM. Barring this information, this paper would be merely a "reference manual"

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for a model developed many years ago. It might be a good idea to convey from the outset that SHUD has many improvements and added features relative to PIHM.

Along the same lines, the only reference provided for the PIHM model is a PhD thesis (Qu, 2004). To help the reader appreciate the evolution of the model from PIHM towards SHUD (there was a FIHM model at some point as well, I believe), it would be useful to cite some of the papers that represent key development stages of the modeling framework and significant applications.

The paper is also lacking in citations (and accompanying contextualization with respect to PIHM/SHUD) of physics-based, distributed, integrated, surface-subsurface hydrologic models (ISSHMs) that are perhaps in many ways more similar (relevant) to PIHM than some of the models that are cited in the paper (VIC, HEC, HBV, SWAT, ...).

The model is described as multi-scale but the actual physical scale most suited for application of the model, if there is one, is not really made clear. There are integrated hydrological models for field-scale applications and for continental-scale applications (and everything in between), and each of these models is very different. Where does SHUD fall? (Are the three test cases - a 3 m long sandbox, a v-catchment less than 1 sq.km., and a 200 sq.km. watershed - a reflection of the range of scales most suited to the model?)

Unless it is standard practice for GMD papers, I don't think the (very long) nomenclature is needed for this paper. Describing each variable (and its units) when it first appears should be sufficient.

The paragraph from lines 164 to 169 seems out of place. It can perhaps be merged with the first paragraph of the Intro?

There is a tendency in the paper to justify some of the key assumptions underlying the model as being perfectly reasonable (e.g., lines 211, 214, and 230-231), whereas of course reality is much more complex and some of these assumptions may actually

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represent serious limitations of the model. The authors should maybe try to be a bit more nuanced regarding the key assumptions behind the model.

There is missing information for the Bergstrom reference.

The (insanely!) long list of authors for the Bloschl reference is made even longer by repeating the entire list from Duthmann onward.

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Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2019-354>, 2020.