

Geosci. Model Dev. Discuss., referee comment RC1
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Comment on gmd-2021-310

Anonymous Referee #1

Referee comment on "Supporting hierarchical soil biogeochemical modeling: version 2 of the Biogeochemical Transport and Reaction model (BeTR-v2)" by Jinyun Tang et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-310-RC1>, 2021

In the paper "Supporting hierarchical soil biogeochemical modeling: Version 2 of the Biogeochemical Transport and Reaction model (BeTR-v2)", authors Tang, Riley, and Zhu develop a new version of BeTR—a model development framework enabling investigation of different levels of complexity, process representations, and numerical method implementations. The new version (BeTR-v2) implements new numerical algorithms, is said to be more efficient software, and can be run independent from host models. To demonstrate, the soil biogeochemistry model of ELMv1-ECA was implemented in BeTR-v2. The numerical solution was compared to analytical solutions, and simulations were performed at multiple scales (single layer, 1D, and global), comparing ELM versus ELM-BeTR model configurations. Global simulations were benchmarked using ILAMB. Overall, this is a nice paper presenting tools and concepts that will be of interest to the GMD readership.

The most interesting result was that the different numerical implementation of ELMv1-ECA in BeTR-v2 led to substantially different predictions. Re-calibrating some of the key parameters was not sufficient to reduce these differences. I agree with the authors that this is an important source of uncertainty that is often not considered in the biogeochemical modeling community. I think this point could be better highlighted in the paper, though. For example, numerical methods as a source of uncertainty is mentioned in the middle of a list in the introduction, but not much is done to highlight or elaborate on this point (even though it becomes one of the main take-home points in the results and conclusion).

I also think several aspects of section 2 could be clarified. This is a model description paper, so developments in this new version should be at least briefly described (even if they've been detailed elsewhere). For example, how is the code "more efficient" and could more details be provided regarding the new numerical algorithms? Please briefly describe the "multiple-flux-co-limiting solver" at first mention.

I also suggest to clarify Table 1. This is important for keeping model configurations straight, but was not intuitive. For example, is the best description of the BeTR configurations really "Based on src/Applications/soil-farm/v1eca". The reader is left to mine the text to understand what this means. Also, the BeTR configurations used the multiple-flux-co-limiting solver for belowground processes too, right?

Minor comments:

P1 L14-16: This sentence is kind of vague with regard to the algorithms and structural improvements.

P3 L19: change "share" to "sharing"

P7 L1-3: The structure of this sentence is confusing The analytical solutions should follow the colon, not equation 3.

P9 L15: Elaborate. What previous findings?

P10 L18-19: "Comparing ELMv1-ECA and ELMv1-ECA"?

Figure 1: X-axes look like the title of the panel below.

P14: Fig 2c is not referenced in the text.

Figure 3: Maybe make ELMv1-ECA a thicker line so that the reader can easily tell which model it is hidden behind.

Table 2: Similar issue as above. I think one of these should be ELMv1-BeTR-ECA.