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Interactive comment on "BioRT-Flux-PIHM v1.0: a watershed biogeochemical reactive transport model" *by* Wei Zhi et al.

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This manuscript presented a recently developed watershed-scale biogeochemical model and its various applications for the two water-table, and DOC and nitrate at Shale Hills watershed. Currently there is an urgent need in the field for such watershed-scale reactive transport codes and the model developed in this manuscript has a wide potential to reach a broad biogeochemistry community. The manuscript is generally well-organized in model materials and has done a decent job validating the model against the benchmark code CrunchTope. I enjoyed reading the most part of the manuscript yet it is lengthy and could be shortened for conciseness. I think the model presented here will be of interesting to many others who are interested in understanding the interaction of land surface, hydrological, and biogeochemical processes. Yet the manuscript

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also needs a major revision to reduce its length, re-organize its structure, and make some clarification. Therefore, I am supportive of its publication after the major revision. Some detailed comments are listed below.

Comments: 1) Figure 1 is a very nice conceptual figure. But it is not clear how the ET is calculated, i.e., what form does it has (e.g., evaporation, transpiration, or even snow sublimation). It is also not clear what does the dark green (e.g., microbe-mediated redox reactions) and shallow green (e.g., mineral dissolution and precipitation) means in the legend.

2) Figure 2 is a useful representation for detailed hydrological processes yet I think the author need to make it more explicitly (or highlight) in the figure about the "two water-table" concept, which is a new model development feature for this study. Does the deeper zone have ET process? How does different water flux terms relate to each other (from the water balance perspective)?

3) The hydrological equations are 2.5 pages long and some of them are repetitive with the same set of equation only in different layers. This section can either be shortened or moved into SI.

4) Macropore and its equation are presented yet are not mentioned or discussed in the later part. Is it also a new feature for the model development, if not, consider remove it.

5) Equation 14, not sure how the hydrology model and bioRT coupled together, i.e., need to be more specific about which terms in this equation are from the hydrology model? Are they coupled outside the hydrology model or coupled internally?

6) Consider reduce the section of 3.2

7) Line 359, not sure if this "numeric scheme" is necessary. Not very relevant to other materials.

8) Figure 5, what are the multiple orange ET arrows, from soil, tress, and snow?

9) Font style is not consistent in Table 1.

10) Some references in Table 1 are missing from the reference list. For example, Leila 2020 (preprint DOI maybe?).

11) Line 485, and Line 493, there seems no mentioning about how was the modeled ET calculated. Consider provide an ET equation or a reference.

12) I like the way Figure 6b was presented. This figure makes sense to me and the upper bound of 40% GW contribution is generally consistent with literature. One tiny thing to improve is the small font size of Figure 6a legend, especially the subscript and superscript.

13) 5.2 Reactive Transport Example, this section already has sufficient details about N reaction. This makes me wondering whether the 3.2 section should be shortened for conciseness.

14) 5.3 Reactive Transport Example 2, it seems to me that the model is flexible in model domain setup. In addition to more model inputs (e.g., spatial information), what are other requirements or burdens in using a spatially explicit model.

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