

Interactive comment on “Exploring New Topography-based Subgrid Spatial Structures for Land Surface Modeling” by Teklu K. Tesfa and Lai-Yung Leung

Anonymous Referee #2

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Current land surface models lack of addressing topographic information in their subgrid structures. In this study, the authors give two types of subgrid structures (geo-located and non-geo-located) over the topographically diverse Columbia River basin in the Northwestern United States using two topography-based methods (Local and Global) for watershed discretization, and the research topic is interesting and valuable. Generally, the methods are sound and have potential being used in land surface modeling. Therefore, the manuscript can be accepted to be published in the Journal Geosci. Model Dev. before some concerns given below have been addressed.

General comments:

1. The first concern is about the evaluation method. When comparing the Local and

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Global methods, as well as the geo-located and non-geo-located structures, the authors tended to choose the options that are less sensitive to the values of area threshold because it can provide more robust subgrid structures for representing subgrid topographic heterogeneity. The sensitivity maybe be a key criterion to evaluate the subgrid structures. In reality, before simulation, we will set a certain area threshold based on the computational resources, the advantage of the discretization methods and subgrid structures should be evaluated under that certain area threshold. A more robust (or less sensitive) subgrid structure cannot ensure a better performance in a given area threshold. For example, in the Figure 8c and 8f, the standard deviations in subgrid structures size are lower for geo-located structure than non-geo-located with a 1% area threshold, and to the other thresholds, the situations are quite reverse.

2. Also, using the standard deviations in subgrid structure size to judge the performance of Local and Global methods is seems not reasonable (Figure 9). When applying Local method to discrete the subbasin, the size factor is implicitly included by dividing RA into several quasi-equal parts. However, in the Global method, the size factor is not considered. So it is natural that the standard deviation in subgrid structure size of Local method is lower than Global method. Moreover, the standard deviation in subgrid structure size is also not directly linked to the performance of each method or structure. It is better to define other criteria to judge the performance for each option or at least remove this unfair comparison from the manuscript.

3. When we compare two methods or two structures for subgrid scheme, the performance of each option under same computational task (number of subgrid structures) is expected, while an appropriate area threshold is pre-prescribed. In this study, there is no such comparison. Therefore, I think at least the author should find a threshold at which the two methods (or subgrid structures) share the same number of subgrid structures, and do the comparison (for the standard deviation in elevation, precipitation and temperature in this study) under this area threshold. From the Figure 8a, 8d and Figure 9a, I do believe such area threshold exists. However, to the Figure 8a, it is also

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very curious that why the number of subgrid structures in non-geo-located structure can be more than it in the geo-located structure when area threshold is set to 4% and 5%. Intuitively, the number of SUs in non-geo-located structure should be always fewer because different subgrid structures (but with same elevation characteristics) in geo-located structure are combined to a same subgrid structures in the non-geo-located. The author should explain clearly about this abnormal effect.

Specific comments:

L144-146: The model code (Table1 and Table2) should be moved to supplementary material, and instead give a brief description about the procedure of what this code expresses in the manuscript.

L165-179: Please add another member that using Global method, geo-located structure and including the topographic slope in these comparisons to show that how the performance of Global method can be improved when the slope effect is considered.

L195: The title is not appropriate. No land surface processes were shown here, only precipitation and temperature.

L195-211: Some important information was missing here. How do the authors interpolate the precipitation (or temperature) from subbasin-level to subunits-level, or how can we get the Figure 14b from 14a? Much more detail information about proceeding method should be added.

L195-211: I think beside results from the option of Local method and non-geo-located structure, results from other options (Local method and geo-located structure, Global method and non-geo-located structure, Global method and geo-located structure) are also expected to be displayed in Table 3, Figure 13, and Figure 14.

L195-211: Please add spatial distribution for NDVI as it does to the precipitation in Figure 13. Also, the statistics about NDVI should be added in Table 3.

Figure 7, Figure 8 and Figure 9: These bar plots are not clearly displayed. Please

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redraw these figures to make them discernible enough.

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