Review of "Enhancing the representation of subgrid land surface characteristics in land surface models" by Ke Y., L. R. Leung, M. Huang, and H. Li

Authors have proposed a new subgrid classification (SGC) method to account for elevation and vegetation variability in a given grid cell in land surface models. The new SGC method optimally divides a grid cell into a number of unique combinations of elevation and vegetation classes. Authors have evaluated SGC method performances in terms of its ability to explain observed elevation and vegetation variability from 500 m resolution data. Authors have also evaluated SGC method performances at different model resolutions: 0.1°, 0.25°, 0.5°, 1.0°, and 2.0°. Authors find advantages of new SGC method compared to other methods with moderate computation load and at coarser model resolution. The manuscript is well written, subgrid variability issue has been investigated in detail, and conclusion follow through the evidence presented in the manuscript. I have some comments (mostly minor) that may be helpful in improving the manuscript. I recommend publication of this article after these comments have been addressed satisfactorily.

General Comments

(1) Section 2.3 (Page 2183 to 2184)

(a) A simple schematic diagram of one grid cell showing default CLM subgrid classification method on one side and new SGC method on the other side would be helpful. Particularly, highlighting the advantages of new SGC method compared to the default CLM method.

(b) For "M X N subgrid classes" or "N_class": you may want to use a new term e.g. Land Response Unit (LRU) or some thing similar to that. Where LRUs are unique combination of elevation and vegetation classes in the given grid cell. Otherwise, it is difficult to differentiate between 'elevation classes', vegetation classes/types' and 'M X N subgrid classes'.

(c) Criteria for optimal classification: "(1) the elevation range for each elevation band is less than or close to 100m". I think, fixing 100m values is affecting your results, e.g., you have more elevation classes at the expense of less PFT classes in the complex topography terrain of western United States regions (e.g. Fig. 6(a) and (b)). I was wondering if making '100m' values a variable, something similar as you did for PFT, would be of any help. For example, for PFT you have a criteria of minimum 80% of PFT variability in the given grid cell. Can you come up with similar criteria for elevation too?

(2) Some clarity is needed in default CLM computation burden and the computational burden from the new method. For example, in default CLM a grid cell can have maximum 4 PFT classes, where as in SGC method a grid cell can have maximum 24 LRUs, that is 6 times increase in the computational burden of CLM.

(3) Figs. 9 and 11 are hard to follow through. Please consider simplifying these figures. One idea could be separating the effects of 'N_classes' from the effects of 'SGC, SGC1, and SGC2 methods'.

Detail Comments

(1) Line 19, Page 2178: "different perspective of surface cover classification". At this point reader does not know what different perspective is? Please clarify.

(2) Line 2-4, Page 2179: This line may be not required. Because, you have already discussed before that you are implementing SGC method in CLM.

(3) Line 26 to 27, Page 2180: "However, conventional subgrid methods usually considered only one parameter, i.e. either vegetation or topography distribution". I think, generally land surface model only considers the vegetation types and not the elevation variability. Also, as you have found vegetation distribution, and elevation variability is generally correlated in complex terrain.

(4) Line 4, Page 2185: "… with similar computational burden at different model resolution". This line is not clear to me. Please clarify.

(5) Line 14, Page 2187: "At both spatial resolution …" I do see this statement true for 1.0° model resolution (Fig. 3(b)).

(6) Line 9, Page 2188: "… number of elevation band per PFT ..". Please consider adding "… number of elevation band per PFT (= 1)….".

(7) Line 26 to 27, Page 2188: Figure reference does not seem right. For example, Fig. 4(b) shows number of elevation classes and not the N_class or LRUs, if I understood it correctly.

(8) Line 8, Page 2189: Please remove 'because driven by climate"

(9) Line 6-9, Page 2191: Please write an equation in the methodology section for % PFT explained.

(10) Line 2, Page 2193: Fig. 10a. -> I am not sure if this figure reference is correct. Also I find it hard to verify "9.4 to 63.4" in Fig. 11a.