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Geoscientific Model Development Discussions

Interactive comment on "A reduced order modeling approach to represent subgrid-scale hydrological dynamics for regional- and climate-scale land-surface simulations: application in a polygonal tundra landscape" *by* G. S. H. Pau et al.

Anonymous Referee #1

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General Comments:

This paper presents a reduced order model (ROM) to resolve very fine resolution soil moisture structure in tundra landscapes. The reduced order model is essentially a statistical model developed using principal component analysis, or "principal orthogonal decomposition mapping method" as stated by the authors. They present this ROM method as a way to improve representation of sub-grid scale heterogeneity in land sur-

face models used for climate simulations (grid spacing of O(100km)). Overall, they show the ROM has promise and is able to capture fine scale features from large scale simulations with generally O(10) bases.

The development of this type of sub-grid scale parameterization is novel and likely will have future applications in biogeochemistry modeling. However, the article is somewhat hard to read in places due to usage of the past tense in areas where the present tense should be used. I am also concerned with the ability of this method to be generalized to larger areas and more diverse landscapes.

Specific Comments:

1) The authors attempt to show transferability and general applicability of this type of ROM to many landscapes, but the development of the generalized ROM is for essentially the same landscape type over a very limited area. The four test sites are all very close together and only cover around 40,000 square meters. It would be very worthwhile to see a general ROM work across landscape types. More discussion of how to develop ROMs for larger areas is needed at a minimum. Would a ROM for each grid cell from a predetermined grid be made, then applied in a large scale simulation? Would there be only N number of ROMs globally?

2) The driving simulation is at 8 m resolution which is at least two orders of magnitude smaller than even the highest resolution regional climate simulation using CLM. What resolution would a ROM developed from a large-scale forcing grid of O(1 km) be produced at? Can a ROM even be developed to generate the correct structure at the required resolution for the biogeochemistry simulations from that forcing grid?

3) Since a ROM is not physically based, how will changes in climate or hydrologic response in time be captured? The authors note that proper sampling of the full forcing phase space will help increase generality, but what about situations occurring in the future that may not be in the observed record?

4) The tense throughout the article is incorrect. The authors use past tense to describe work in this paper, which gets somewhat confusing. For example: Page 2131, line 5: “To that end, we described, tested and applied” This is referring to work in this paper? If it is, the tense should be present: "To that end, we describe, test and apply". Many pages describing the work have this issue.

5) I wonder about the last statements of the article regarding topographic differences between the study sites. What are the units in Figure 1? If they are meters, there is only a 1 m range in the color bar, indicating very little topographic variation. What about a region of steep, complex topography where there may be 20 m elevation change over a 100 m plot, then the next 100 m plot is flat? How would that impact a site independent ROM?

Technical corrections:

Page 2127, line 23: Change to: “wetland biogeochemistry and occurs at scales”

Page 2132, line4: What does the “O” stand for in BEO? Should it be “Barrow Environmental Observatory?”

Page 2132, line 14: Change to: “the majority of precipitation falling during the”

Page 2134, line 27: Change to: “Eq. (3) in Sect. 3”

Page 2141, line 14: Should it be: “e_(Δx_g)ˆ(-POD-MM)” the second time on this line?

Page 2141, line 16: Should it be: “Δxg = 0.5 m, e_(Δx_g)ˆ(-POD-MM2)” You may want to re-check super and subscript notations elsewhere.

Figure 1: Units are needed on color bar. Also would be nice to have X and Y distances on the axes to have an understanding of how big the study sites are.

Figure 3: Y-axis is labeled as a PDF, it may be better to normalize the histogram counts so it is truly a PDF.

Figure 4: Units for X-axis

Figure 9: Units needed

Figure 10: Units needed. Also, color range doesn’t capture range of values well for most panels, should change.

Figure 15: Using the same Y-axis range for both panels would be helpful.

Figure 16: Again, normalize the histogram for the PDF.

Figure 17: Units needed.

Interactive comment on Geosci. Model Dev. Discuss., 7, 2125, 2014.