

Interactive comment on “Modelling northern peatlands area and carbon dynamics since the Holocene with the ORCHIDEE-PEAT land surface model (SVN r5488)” by Chunjing Qiu et al.

Anonymous Referee #2

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Qiu et al. present their new peatland model, ORCHIDEE-PEAT (v2) and use it prognostically simulate peatland C, extent, and depth over the Holocene. Their work borrows from previous efforts using TOPMODEL based approaches but they extend the field by allowing their model to determine where peatlands will initiate and expand. I find the work to be on the whole sound and interesting. The problem they are tackling is far from trivial and I am surprised it does as well as it does. I am a little concerned about the poorer performance in the major peatland complexes of the world (Hudson's Bay and West Siberia) which I get to in my comments. The paper is generally easy to follow and has relatively few typographical/grammatical errors. I think the paper is publishable in GMD but would like to see my comments addressed prior to that.

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Main comments:

1. The paper seems to sometimes confuse wetlands and peatlands. While peatlands are a type of wetland, in the paper the distinction can be at times very fuzzy. For example, in the abstract it says 'A cost-efficient TOPMODEL approach is implemented to simulate the dynamics of peatland area, calibrated by present-day wetlands areas that are regularly inundated or subject to shallow water tables' (lines 28 - 30). Since it is very possible to have a non-peatland wetland be 'regularly inundated or subject to shallow water tables' this makes it confusing at a minimum. Later in the supplementary material some model parameters are tuned, grid cell by grid cell, to 'select the combination that matches with the CW-WTD wetlands map'. So it appears quite unclear that this is indeed a peatland specific parameterization. I realize that there are other steps to determine if peat will begin to form at the site (e.g. Fig S2) but the implementation of the wetland/peatland determination scheme is confusing. Why tuned to wetland area if that will include many non-peat wetlands? Is the idea that the peatland initiation scheme can handle the rest? Can the authors try and bring a bit more clarity to that aspect of their technique?

2. I fully understand the authors' point about difficulty in simulating small permafrost complexes (e.g. discussion of Fig 6) but I am concerned about the poorer performance in the major complexes such as the HBL or WSL. Both of these regions have areas of near 100% peatland cover so the model should have a good chance. Also there is an overabundance of peatlands in some regions that are generally devoid of peatlands (e.g. E. USA). Is this 'smearing' of peatlands perhaps a result of how wetlands area is generally determined, i.e. TOPMODEL-based, or is this a result of the peat initiation limits? I think this deserves more discussion in the paper as it is a striking aspect of the result and one that the community would benefit from any lessons learned regarding how to best get the hotspots without overdoing the rest of the domain.

Minor comments:

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1. line 202 - does that mean the peatland PFTs are forced into their gridcells? Can you expand on what peatland PFTs there are? I see that there are some mention in Text S1 but it just says a PFT with shallow roots. Is it a tree? Do you simulate any other peatland specific PFTs? Shrubs? Moss? Sedges?
2. line 224 - Since Fan et al. 2013 is a model-based product perhaps add in 'simulated' in the description.
3. line 265 - Does the peatland HSU immediately shrink to the new potential peatland area fraction? No lag or delay?
4. line 282 - Why is the old peat treated as mineral soils? That strikes me as strange. The soils would continue to have high C contents for quite a while if drained so treating as a mineral soil seems unreasonable. Please expand on this logic.
5. line 400 - Didn't understand the last sentence there.
6. line 447 - How many cores were simulated as non-peat out of the total?
7. around line 476 - please specify 'simulated'. It gets a bit confusing that these are all just model quantities.
8. line 626 - This is where I find the technique a bit confusing. 'We notice a large interannual variability in peatland area'. In reality this is unlikely to be possible given that peat soils are slow to develop and slow to leave. The water-logging is the dynamic aspect. This sort of ties into my main comment #1 above. Please tighten up how this is all defined and referred to.
9. Fig 1 - Strange figure. I couldn't figure out the green fade, nor understand how it was giving information. So is the above the green the >100% RMSE? Why a fade? Please rethink this one.
10. If Fig 6 is plotted as a simple scatterplot, what does it look like? I understand that Fig 7 is a more detailed look but I wonder if a simple scatter plot could be instructive

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for any bias.

11. Fig 10 - please split into 3 separate bars per time period. I couldn't figure this out. What is the light blue? What is the line midway through 8-10 Age bar meaning?
12. supplementary line 11 - So does all of the surface runoff from the grid cell get funnelled into the peatland HSU? Why only surface and not subsurface?

p.s. Apologies for the slow review. There was some confusion between me and the editorial team if I was providing a review.

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