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Interactive comment on "Assessing effects of permafrost thaw on C fluxes based on a multi-year modeling across a permafrost thaw gradient at Stordalen, Sweden" *by* J. Deng et al.

Anonymous Referee #2

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Summary comments

This paper provides useful modeling of coupled biogeochemical and thermal dynamics within a thawing peatland at Stordalen, Sweden. However, the field design (land cover site types) and model specifics are not always clearly presented, and the characterization and interpretation of the model results could use some reworking. There are grammatical issues throughout that weaken the paper but are likely easily fixed. I would be interested to see results for soil thermal conditions in relation to predicted fluxes – and particularly in relation to episodes where simulated and observed fluxes do not agree – more explicitly presented or discussed. Ultimately, the authors should discuss what Stordalen represents relative to other peatland permafrost environments.

Detailed comments

3963 title: The peatland environment should be specified as this study is not representative of all permafrost sites

3965, 1: please consider other work here – e.g., Tarnocai et al.

13: Please provide more recent references to permafrost thaw in northern peatlands – there is ample recent work in this area

19, 22, 28: dropped article (“the”) in front of “C cycle”, “C balance”

3966, 16: grammar - “may be resulted”

3967, 1: Clarify why this is an improvement over just looking at the measurements?

15: grammar -“hydrology, vegetation, and subsequently. . .”

24 and throughout: “Palsa” is indicated in parallel with species names when it is a term that indicates a ground ice landform category – please clarify

3968, 3-4: “different stages of permafrost degradation”; please be more explicit. The implication is they are not sequential, so what do they represent?

10: Seems premature to mention the sign convention here – move to where it is first used?

3970, 12-14, 15-16: grammar - “as well as” should be “or” or similar

27: grammar

3971, 1-2: grammar “and their effects”

3972, 7: “ran” should be “run”

9-10: Do the vegetation and biogeochemistry feed back to the thermal module? This seems important to mention here and discuss later.

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19: missing article (“the permafrost thaw gradient”) – related grammar issues not always identified but entire manuscript should be edited for this

21-24: Is GWP the best approach? Why not use the approach of Frolking et al., 2006 (JGR 111)?

3973, 17: “mesic” and “wet” are not parallel terms and their use here is unclear; please specify relevance of these modifiers.

20: “gradient of soil moisture”; this should have been introduced back at page 3968 in describing the study design. How do these sites represent a gradient? This may be specified in other Stordalen literature but is an essential component of study design that should be specifically described.

21: Please re-state in terms of the relationship between thermal conductivity and soil moisture.

23: “few” should be “a few” for correct implication

3974, 1 (from previous page): the downward dip is persistent in all simulated years – model seems to chronically overestimate thaw rate and to produce the inverse time trend (increasing rather than decreasing thaw rate). Please modify description accordingly.

20-21: How does RMSE=13% indicate “success”? How good does the simulation need to be?

22-23: Please state criteria and reasoning for “generally captured” vs. “discrepancies appeared in 2003”. There are discrepancies in every year.

26: Shouldn’t soil temperature be a driver here rather than air temperature?

3975, 1: Low R is 0.32

6-8: “successfully predicted” and “good agreement”; again, what constitutes success?

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As with the Sphagnum sites it seems R is not the best metric of fit since 2004 (3p) looks to have systematic offset despite R=0.52. Is this a result of inaccurate simulation of soil temps early in some years as appears to happen in 3h?

17-18: “reliably simulated” – same comment as above: what are the criteria? What is the goal of the simulation?

20: water tables – use of observed vs. simulated seems like methods rather than results. Also, did WTDs account for the rise and fall of the floating mat? How was the “ground surface” height assessed?

26: “generally matched”; please quantify.

28: grammatically unclear.

3976, 1-2: Appears circular – isn’t this what the model does rather than a result of the model? A figure indicating these relationships in the model might help.

1-8: The simulation appears to capture some early and late season spikes consistent with literature (eg, Mastepanov) – how does this happen in the model? Seems important to mention as the shoulder seasons can be hard to capture with observations.

11: grammar - “few biases”

11-13: Please provide some explanation of why this offset is mentioned when others aren’t, as well as insight about where the model indicates relationships other than what is hypothesized to go on.

14 and throughout: What does a p value indicating “significant” mean in this situation given the number of observations? Capturing seasonal trends but not detail?

16-18: How did the modeled results demonstrate a relationship to soil temp, etc.? Seems reasonable but these results are not presented and this explanation has not been posited previously in this manuscript.

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18: “because of inundated conditions”; Please specify how inundated conditions relate to soil temp, etc., and show how the model “demonstrated” these relationships.

21: “well captured” – grammar issue

3977, 9-10: HOW did differences in these environmental conditions influence simulated NEE? The land cover type differences have not been described.

10-12: high CO2 uptake “due to” high productivity seems circular, not causal. 15: low CO2 uptake “because of” low productivity also circular, not causal.

3978, 10: “permafrost thaw gradient” – The relationship among these land cover types was described as a “gradient of soil moisture” back at 3973, line 20, and the Eriophorum and Sphagnum types were described as two possible outcomes of palsa conversion on page 3968, lines 1-2 – implying either could happen, not a sequence from one to the other. Please describe clearly what the site types represent in the methods section so that the study design is clear. This may be represented in other papers but is critical to describe here.

15-18: “stronger warming potential”: Again, consider the approach of Frolking et al., 2006 with respect to warming potential in peatlands, or explain why this has not been done. Also, is this difference significant? What is “stronger warming potential”?

21-24: What about conversion among types? Was sphagnum ever converted to eriophorum or vice versa? If not then the “permafrost thaw gradient” statement above should be modified.

27: “wetter trend”: please reword for clarity

3979, 2: “areas changes”; please correct grammar for clarity

6: Are these values really significantly different than zero given large range? Is there really net warming under a peatland scenario of ongoing emissions per Frolking? The lack of winter observations is mentioned subsequently, but this is an additional uncer-

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tainty that bears mentioning here.

12-13: “stages of permafrost thaw”: please clarify in methods and throughout as mentioned above

16-20: Seems too broad. Please clarify whether the model captures transitions among site types rather than just seasonal to interannual variation in fluxes for a site type with changing atmospheric conditions. Are transformations of hydrology and vegetation modeled? Does the model predict when palsa is transformed to sphagnum, etc.? Based on page 3983, lines 5-7, it does not; please reword this section accordingly.

22-23: “on some days” - many or a few? Tended to overestimate? Please clarify and specify. Overestimated CO2 uptake resulting from over-prediction of photosynthesis again seems redundant or circular, not causal.

3980, 5: again, what about soil temp, perhaps due to prior air temp conditions or snow cover? Not a factor? What about biogeochemical processes influencing belowground temps in ways not captured by the model? 9: “few inconsistencies” should be “a few inconsistencies”

3981, 25-26: good point; please evaluate the degree to which classes and replication of them as well as measurement points within them are adequate at this site.

3982, 4-6: Are there observations of soil temp that could be compared to the simulations, both for soil temp and gas flux?? Seems very important to show these and reference the literature relating fluxes to soil temp.

18: “soil thaw” should be “seasonal soil thaw” to clarify that longer term thaw trajectories are not modeled.

Table 1 (3991) Please specify that rates are unitless (m/m per day) if this interpretation is correct

Figures 2-4 please specify years for clarity

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