Dear Editor,

Thank you for the letter along with the helpful comments on the manuscript entitled "Assessing Effects of Permafrost Thaw on C fluxes based on a Multi-Year Modeling across a Permafrost Thaw Gradient at Stordalen, Sweden". We are pleased the manuscript is suitable for publication after minor revisions. We have studied the comments and further improved the manuscript. Our detailed responses are attached below.

Line 59: "As a result of climate warming, degradation of permafrost has been observed…" This phrasing seems to overstate the evidence of cause and effect – in part because some amount of degradation has been ongoing in the discontinuous permafrost zone – these are dynamic systems. Perhaps, "Many recent studies have argued that with climate warming, the rate (or extent) of permafrost degradation is increasing…."? Something like this.

Response: We have rewritten this sentence into "Many recent studies have argued that the rate or extent of permafrost degradation is increasing with climate warming in northern peatlands ".

Line 87: "therefore disregarding" and "ignoring": Consider rewording. Perhaps not disregarding/ignoring so much as effectively making assumptions about scaling effects that have not been (well) tested.

Response: Revised. The words "disregarding" and "ignoring" has been changed to "may be deficient in considering" and "improperly considering", respectively.

Line 146: qualifying phrase was inserted in response to my initial comments but here seems redundant. I meant to ask for more complete description of the plant species assemblages present at these sites. This information seems critical for understanding the paper. I'm curious. also, has there been work done on the age of this peatland? How long has C been accumulating?

Response: The details of the plant species at the study sites have been described by Bäckstrand et al. (2008). This paper has been properly referenced in the revised manuscript. In addition, we have added the information on the "peat age" (Lines 127-128).

Reference: Bäckstrand, K., Crill, P. M., Mastepanov, M., Christensen, T. R., and Bastviken, D.: Total hydrocarbon flux dynamics at a subarctic mire in northern Sweden, J. Geophys. Res., 113, G03026, doi:10.1029/2008JG000703, 2008.

Line 149: "representing intermediate thaw features" – Is this based on dating, field observation of thaw progression, or some other evidence? The authors have responded to previous comments along these lines, but in this section and elsewhere the terminology of "gradient of thaw" and "intermediate" still seem to imply a time sequence, while the

phrase “converted into Sphagnum or Eriophorum” at line 158 implies two alternate thaw scenarios. What I’m looking for here is just clarity about what relationships are known or hypothesized, and what the supporting evidence is. I see that the thaw depths are greater in Erioph. than in Sphag., but this doesn’t require that the Eriophorum scenario follows the Sphagnum. Given the difference in observed methane efflux, it seems important to be careful about the implication of time sequence vs. wetness gradient or alternate thaw scenarios represented (or if either may be true). Later (see comments below), it appears the authors interpret these sites as thaw scenarios – maybe? – but this really should be clarified to appropriately understand the results (e.g., what’s represented in Figure 6 and with change in land cover areas in terms of outcomes). The response comment of “intact, diminishing, or gone” implies a sequence of events. Since observations were made only to a meter and the authors state that palsa may re-form, caution in this wording and articulation of supporting evidence are important.

Response: In general, the Palsa, Sphagnum, and Eriophorum sites represent a permafrost thaw gradient, because these three land cover types have different permafrost regimes and soil thaw rates (e.g., increasing thickness of summer thaw zone and decreasing surface elevation, as described at Lines 148-158). In addition, Malmer et al. (2005) have found that the area of Eriophorum cover expanded mostly at the expense of Sphagnum cover from 1970 to 2000 at the south part of the Stordalen mire, probably as a consequence of permafrost thaw, although the net change of vegetation cover for the north part of the mire and whole mire was Palsa be converted into Sphagnum or Eriophorum dominated land cover (we have clarified this point at Lines 158-163). Therefore, these three land cover types may represent a thaw progression based on the possible shifts in vegetation.

Reference: Malmer, N., Johansson, T., Olsrud, M., and Christensen, T. R.: Vegetation, climatic changes and net carbon sequestration in a North-Scandinavian subarctic mire over 30 years, Glob. Change Biol., 11, 1895-1909, 2005.

Line 151: grammar, “with water table levels fluctuate”

Response: Corrected.

Lines 347-348: “rate of summer thaw accelerated along the gradient of soil moisture” – The slopes in Figure 2 don’t look different (and are not quantified); do you just mean that the Sphagnum took longer than Eriophorum to go deeper than a meter? Or that both went deeper than Palsa? Please clarify.

Response: We have added a sentence to clarify the modeled thaw dynamics at the study sites (Lines 352-355).

Line 539: “increased along the thaw gradient”; this implies a thaw sequence that turns on understanding the Sphagnum site as representing an intermediate state between the palsa and the Eriophorum site. Is this the understanding here and if so, based on what evidence (see comment on line 149)?

Response: The representativeness of the study sites were based on the differences in permafrost regimes and soil thaw rates across the sites (e.g., decreasing surface elevation and increasing thickness of summer thaw zone) and shifts in vegetation and hydrology mentioned in the published literatures. Please see the response to the comment at Line 149.

Line 558-559: “Given that the soil thaw rate accelerated under wet conditions (Figure 2), this trend toward a wetter ecosystem may further accelerate permafrost degradation.” Do you mean this very generally for the two site types vs. Palsa, or from Palsa to Sphagnum to Eriophorum? Please clarify and make parallel with the site type distinctions in methods.

Response: Here, we generally mean the observed changes in vegetation cover, i.e., from Palsa into Sphagnum or Eriophorum. This point has been clarified (Line 567).

Lines 665-667: Here it seems that the site types represent two thaw scenarios relative to Palsa. This should be clarified at points indicated above.

Response: We have clarified the representativeness of the study sites. Please see the response to the comment at Line 149.

Line 729: “should have set a sound basis for the model to incorporate” – consider rewording as “provide a sound approach to incorporating”

Response: Reworded by following this suggestion (Lines 737-739).

Line 1101: Figure 4 caption is a bit confusing with respect to a-g symbols vs. those in next two columns. This should be clarified. The figure could be changed so that the first column looks more distinct.

Response: A note has been inserted to clarify that the water table depths at both the Sphagnum and Eriophorum sites are shown in the panels (a to g). In addition, we have refined this figure to make the first column more distinct.

Line 1133: Thanks for the addition of Figure 5. Consider adding labels (eg, “Sphagnum; WT>-10 cm) to the panels for clarity.

Response: Labels have been added by following this suggestion.

Please also note the attached revised manuscript.

Sincerely yours,

Changsheng Li and co-authors