

## ***Interactive comment on “Reviews and syntheses: Changing ecosystem influences on soil thermal regimes in northern high-latitude permafrost regions” by Michael M. Loranty et al.***

### **Anonymous Referee #2**

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Permafrost grounds will undergo pronounced changes in a warmer climate. In the current manuscript the authors focus on how high latitude terrestrial ecosystems influence surface energy fluxes of permafrost soils, and therefore the current soil thermal state and fate of future permafrost degradation. They discuss many aspects of ecosystem/vegetation interactions with the soil thermal regime – interactions which are key to predict future changes in permafrost conditions, but which are not represented (or only represented in a very simplified manner) in current Earth System Models. The authors consider individual processes not in isolation but especially discuss a broad picture of interaction among key processes. Given that current understanding of vegetation-permafrost interactions is incomplete, and that the topic touches on an important as-

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pect for model improvement, I consider the paper of broader interest to the readership of Biogeosciences.

### Major aspects

1. The multitude of aspects discussed in the manuscript makes it rather difficult for the reader to extract which key processes are likely to govern permafrost-vegetation interactions (under present day conditions and under future climate change). The authors put a lot of effort in discussing a broad spectrum of vegetation-permafrost ground interactions which all influence permafrost soil thermal regimes. Many examples of these interactions reveal the possibility of either a net positive or a net negative feedback, depending on factors such as local topography, climate, soil conditions, etc. A “synthesis” of current knowledge about ecosystem changes and related impacts on permafrost soil conditions would have added value if the discussed aspects of vegetation-permafrost interaction in this manuscript would be summarized such that the reader can judge the broad-scale importance/representativeness of individual processes. In this regard an additional table or figure would be very helpful, which summarizes the discussed aspects in the text and which could list/illustrate

a) the key physical process chains discussed in this manuscript, indicating whether the interactions are likely to result in a net positive or negative feedback (on ground temperatures, or on carbon cycling), or stating that the sign is unclear given current knowledge b) the factors which drive the sign of the feedback (e.g. topography, climate)

To the degree possible, it would also be interesting to illustrate in this table/figure whether feedbacks will rather amplify or dampen under expected Arctic climate change, and (in line with the discussion of fire impacts on page 21) whether changes are reversible or irreversible (on human timescales).

2. A key uncertainty of future high latitude ecosystem changes will come from changes in the hydrologic regime, determined by changes in precipitation, evaporation, and drainage. Projections of these changes are highly uncertain. This aspect should be

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discussed in the manuscript as future high latitude vegetation responses will follow rather different trajectories for wetter or drier conditions (compared to today). In this context: Fig. 4 assumes a reduction in future (?) moss cover, and an increase in vegetation canopy cover. What are the assumptions behind made here?

3. One objective of the paper is stated as: “ to identify key challenges and research questions that need to be addressed to better constrain how continued climate-mediated ecosystem changes will affect soil thermal dynamics in the permafrost zone.”

I might have overseen a discussion of this aspect in the manuscript, but at least in the conclusion section a reference is only made by stating that integrated analyses of processes are needed. A discussion of more concrete aspects would be helpful.

#### Minor aspects

L61: double occurrence of sentence L 79/80: can you give a reference here? L 126: what is meant by “internal energy transfers”? L 269: Kt depends also on the thermal state (ratio of liquid to frozen water) L688: “available evidence. . .” can you give a reference here? L 1507: (H) instead of (S) Figure 2: what is meant by “Climate” as change agent – increases in temperature?, what about climate change induced changes in precipitation? Figure 3, L1534: can you give numbers here? Figure 4: OLT is not explained

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