

## ***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 #1**

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The authors summarize a wide a range of findings on interactions between vegetation, hydrology and soil temperatures in permafrost. A review paper on these complex processes could fill an important gap in the literature. Unfortunately, I am not sure whether the manuscript in its present form achieves this aim. Rather than synthesizing a large spectrum of studies, the manuscript feels disjointed at times. For instance, the impact of hydrological changes is treated separately for winter and summer, thus neglecting important interactions and potential feedbacks. The manuscript also falls short of fulfilling the promise contained in the title, namely the elucidation of the soil thermal dynamics. While the ground heat flux at the soil surface is discussed, many other important aspects of the soil’s thermal regime, such as mean permafrost temperatures,

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temperature profiles, seasonal amplitudes, ground ice formation, etc., are given very short shrift. I hope that the following comments will be useful to the authors.

### 1) Thermal dynamics

As stated above, I found the discussion of the soil thermal dynamics incomplete. While the ground heat flux is clearly an important factor, it does not tell the whole story. Also, it is coupled to the subsurface temperature profile, so that is difficult to consider in isolation. These issues are confounded by the fact that the relevant time scales at which the ground heat flux varies are barely discussed. For instance, it is apparently implicitly assumed that the values are averaged over at least a diurnal cycle. Furthermore, the interactions between winter and summer processes are largely left out.

### 2) Summer and winter-time processes

I felt there was a lack of balance and integration across the annual cycle, and the manuscript thus falls short of its objective to synthesize disparate information. In addition to the problems with the description of the ground heat flux, I had similar reservations about the discussion of the thermal conductivity. I missed a discussion of how the water/ice content modifies the soil thermal conductivity at below-zero temperatures (not explicitly mentioned), and what the impacts on the soil thermal dynamics are. Also, the impact of snow cover on summer-time conditions (soil moisture, deeper soil temperatures, etc.) is not really discussed.

### 3) Heterogeneity and variability

I believe the co-variability of soil and vegetation properties could be highlighted more clearly, as it has a strong influence on future changes and also on the presently observed patterns of spatial variability. For instance, bryophytes in adjacent wet and dry microtopographical positions often differ greatly in their physical properties. Such interactions can modify observed patterns of e.g. the relation between soil moisture and thaw depths. These issues in interpreting observational (as opposed to experimental

data) are not acknowledged very clearly.

#### 4) Synthesis

I would welcome a greater attempt at synthesizing previous findings, for instance by coming up with testable hypotheses. At present, there are many statements that process X may be important/not important or positive/negative, depending on multiple other factors. By highlighting open questions, or hypothesizing about the most important interactions, the manuscript would be more exciting to read. For instance, the discussion of conductive vs advective heat fluxes would be more informative if the conditions under which large advective contributions are hypothesized to occur (or where they tend to be observed; e.g. in fens in discontinuous permafrost), were mentioned.

#### Minor issues

##### 1) Energy balance 1

The coupled nature of the surface energy balance and the subsurface dynamics is not portrayed very well. For instance, the following sentence suggests that above-ground processes (rather than above and below-ground processes) determine the surface temperature: 'Once energy has been absorbed at the ground surface and TSG is elevated, soil KT will dictate how much of this energy is transferred downward into the soil'.

##### 2) Energy balance 2

I feel that several important influences of vegetation canopies on the energy balance are neglected (e.g., roughness, longwave radiation from vegetation canopies).

##### 3) line 581

ponding is an important aspect in this context

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