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Biogeosciences Discussions

Interactive comment on "Linking tundra vegetation, snow, soil temperature, and permafrost" *by* Inge Grünberg et al.

Anonymous Referee #1

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The spatial distribution of near-surface temperature is characterized with respect to distinct Arctic tundra vegetation communities over the course of two years. Vegetation was found to influence snow cover throughout the autumn, winter, and spring with seasonally variable effects on soil temperature. However, soil temperature was not significantly correlated with vegetation type or active layer thickness during the summer.

General comments: It's well established that tundra vegetation affects snow depth/cover and vice versa with co-varying implications for soil moisture and temperature (see early mountain tundra work by Dwight Billings and Skip Walker among others). However, it's not as well known how these processes combine to affect the spatial variability of active layer depth in permafrost regions. The current study rigorously characterizes seasonal relationships between vegetation, snowpack, and soil temperature

in heterogeneous Arctic tundra, but fails to link these results to permafrost dynamics in a meaningful way. I believe the authors could make this connection by (1) re-framing the results and (2) elaborating on the broader impacts of this work as detailed below.

(1) It wasn't until I read the final discussion section that I internalized what I think is the main take home message and contribution of this work: small scale differences in vegetation and snow accumulation do not affect active layer thickness in this system. I think this (non-)result would generate considerable interest (and citations) if it were highlighted in the abstract, the first discussion paragraph, the conclusion, and potentially the title, but it's difficult to pull out this contribution with the current focus on vegetation-snow-temperature dynamics that are mostly known already. To put it another way, I think the rigorous soil temperature/veg/snow measurements could be leveraged to gain new information about active layer dynamics, as opposed to the main focus being on the measurements themselves.

(2) The broader impacts of the study are not well developed. Why does winter soil temperature matter if it has no bearing on active layer thickness during the summer? What are the implications for shrub expansion or other expected changes/disturbances in these systems? I found this information particularly wanting in the in the abstract and discussion sections. I see this as a natural follow on to (1) insofar as it's your opportunity to describe what the non-result means for future predictions of warming, permafrost degradation, greenhouse gas emissions, etc. This will increase the impact of your work by clearly demonstrating the scientific contribution to other scientists, the media, and the general public.

Specific comments: L15-16: "shrinking snow cover" means less snow-covered area or snow covers the same amount of area for less time?

L17-19: This is the type of broader impact statement that I was looking for in the abstract i.e., why does soil temperature matter?

L25-27: It would be helpful if you could describe the thermodynamic mechanism(s) for

this.

L35-36: And presumably to get additional moisture in some cases.

L40: Missing words here.

L60: Please explain how tall vegetation cools the soil through evapotranspiration. My first thought is that transpiration would dry the surrounding soil, which would lower its heat capacity and make it more vulnerable to summer warming.

L65: Wrong word “and”.

Figure 1: What is the yellow area in (a)?

Figure 2: The colors used to denote the “tree” and “tall shrub” and the “riparian shrub” and “lichen” vegetation types are indistinguishable to me. I don’t see the white plus on the map.

L139-140: I’ve re-read this statement several times now and still can’t wrap my head around it. Please clarify with particular attention to double meanings associated with “mean deviation” and “less than” when referencing a negative number.

L173-174: Is this really the most accurate interpretation of Figure 3 and 4? It seems like the correlations are all over the place to me.

L184-185: Interesting.

L186: I thought the highest soil temps were 0.1C and -0.8C as stated on L183-184?

L206-207: I’d expect soil temp differences to be damped relative to air temp differences. How did snow cover compare between these sensors?

L214-215: I’m very curious as to why the lichen and dwarf shrub snow depth went up between 2017 and 2018 but the tall shrub and tussock snow depth went down during the same period. Okay now I see that you invoke wind redistribution on L222 – might be good to bring in here.

L218-219: Can you provide the regression stats to verify this?

L239-241: This speaks to the first-order control of snow depth as a buffer between air and soil temps.

Figure 7: The take away messages from this figure would be clearer if you showed significant trendlines in (b) through (e) and (g) through (j).

L270: I’m not sure how the first and second mentions of “site” on this line are related. Please clarify (and preferably expand), especially since the first two discussion sentences are prime real estate.

L274: Most variable between sensors or through time?

L278: Please elaborate on what’s meant by “general pattern”.

L279-280: This conjecture would be a lot stronger if it were supported with citations (there are many) as well as a process-based description, especially given the short length of this section.

L288-291: Citations are required for everything you wish to invoke here.

L312: And increasing long-wave emissions.

L319: Same comment as L60.

L319-322: So none of it matters for permafrost? I think you’ve buried the lede here. This non-result should be highlighted as a main conclusion of your work (see general comments).

L330-337: This argument is hard to follow.

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