

The Cryosphere Discuss., referee comment RC1
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Comment on tc-2021-47

Sebastian Wetterich (Referee)

Referee comment on "Recent degradation of interior Alaska permafrost mapped with ground surveys, geophysics, deep drilling, and repeat airborne lidar" by Thomas A. Douglas et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-47-RC1>, 2021

Interactive comment on: *Recent degradation of Interior Alaska permafrost mapped with ground surveys, geophysics, deep drilling, and repeat airborne LiDAR* by Douglas et al. (ms no. tc-2021-47)

The paper by Douglas et al. represents a permafrost monitoring study that combines drilling, thermometry, geophysical and remote sensing approaches to detect permafrost dynamics over seven years in Central Alaska near Fairbanks in an area of discontinuous permafrost distribution. The combination of multiple belowground and aboveground observations allows the authors deducing significant interactions and trends between permafrost and surface features such as vegetation and disturbances over the observation period 2013-20. The permafrost response to current warming is clearly seen in the presented data and comprehensively interpreted by the authors. Thus, the vulnerability of discontinuously distributed permafrost to thaw under current warming is convincingly presented by Douglas et al. The impressive monitoring setup of drilling, ground temperature and thaw depth measurements combined with ERT, and satellite imagery and airborne LiDAR imagery at four different transects is, to my knowledge, exceptional in permafrost research.

The paper is clearly written and scientifically sound. To my opinion, the study by Douglas et al. represents a valuable contribution to The Cryosphere.

However, I suggest to restructure slightly the paper by adding a section 2 Study area (presently it is subsection 2.1) and a section 3 Material and methods. According changes throughout the manuscript are indicated below. Further, I noticed some redundancy in the paper and ask the authors to carefully shorten the text where appropriate. I have some further minor recommendations which are outlined below.

p1 In14: The abstract reads very detailed presenting much of the results of the study. I'd recommend some shortening while focusing on the main outcome of the study.

p1 In24: Add space between '500' and 'm'.

p1 In26: Define 'LiDAR' as your defined 'ERT' at first occurrence in the ms.

p1 In30: Is '... active layer depth *measurements* must be made ...' meant here?

p2 In38: Use subscripted number for 'CO₂' here and elsewhere in the ms.

p3 In46: Specify 'Mean annual *air* temperatures ...'

p3 In53-54: Better use 'ice wedges' instead of 'massive ice bodies' since wedge ice is characteristic for Yedoma and you use this term anyway later on while massive ice is more general and might imply other origin.

p5 In102-103: Do the area calculations refer to Strauss et al. (2016)? Add reference.

p5 In 114: I'd suggest to omit section heading '2. Field measurements' and differentiate the second section as '2. Study area'. Consequently, the third section would start as '3. Material and methods' including the sub-sections '3.1 Satellite and LiDAR imagery', '3.2 Field survey measurements, coring and meteorology', '3.3 Electrical Resistivity Tomography'.

p6 In130: Add space between '400' and 'm'.

p6 In145-146: The statement is also given on p8 In212 and could be omitted either here or there.

p6 In147: Insert section '3. Material and Methods'.

p6 In147: Rename sub-section heading to '3.1 ...'.

p6 In156: Define 'DSM'.

p7 In162: Define 'DEM'.

p7 In169: Rename sub-section heading to '3.2 ...'.

p7 In176: Delete space after 'August'.

p8 In191: Rename sub-section heading to '3.3 ...'.

p8 In194: Delete dot after '4 m'.

p8 In208: Rename section heading to '4. ...'.

p8 In209: Rename sub-section heading to '4.1 ...'.

p8 In212: The statement is also given on p6 In145-146 and could be omitted either here or there.

p9 In216-217: I assume what you see in the LiDAR imagery and describe here are high-centre polygons that remain when the surrounding wedge ice melts. Consider omitting the term baydzherakh here and elsewhere in the manuscript. The correct term however would be thermokarst mound to skip the 'graveyard' nomenclature. Commonly acknowledged definitions on permafrost terminology can be found in van Everdingen, R.O. (1998) Multi-Language Glossary of Permafrost and Related Ground- Ice Terms; https://globalcryospherewatch.org/reference/glossary_docs/Glossary_of_Permafrost_and_Ground-Ice_IPA_2005.pdf. Here, under no. 256 high-centre polygons and under no. 560 thermokarst mounds are defined.

p9 In224: Add space between '310' and 'm'.

p9 ln225: Change to '*P. mariana*'.

p9 ln226: Change to '*B. neoalaskana*' and '*P. glauca*'.

p9 ln229: Change to '*P. mariana*'.

p9 ln243: Delete second dot at the end of the sentence.

p10 ln244: Rename sub-section heading to '4.2 ...'.

p10 ln245-246: Consider rephrasing to 'The mid-June and early August seasonal thaw depth measurements and those in October 2014 show ...'.

p10 ln257: Replace 'fifty' with '50'.

p10 ln272: Add 'at' to '358 m'.

p11 ln278: Add space between '50' and 'm'.

p11 ln287-290: Add a sub-section on radiocarbon dating to section 3 'Material and methods' and a table with the dating results (probably to the supplement) including sample ID, lab ID, sample depth, material, $\delta^{13}\text{C}$, sample mass, and radiocarbon age although some of this information is given as description in Table S1. Please, further consider common nomenclature and calibration to give ages as years before present (yr BP) or calibrated years before present (cal yr BP).

p12 ln316: Rename sub-section heading to '4.3 ...'.

p14 ln358: Rename section heading to '5. ...'.

p14 ln370: Add space between '1.2' and 'm'.

p14 ln375: Consider rephrasing to '... have established *that* vegetation provides ...'.

p14 ln384: Add space between '2' and 'm'.

p14 ln384: Delete space before 'Infrastructure ...'.

p15 ln393: Add dot after 'al'.

p16 ln430: Because ground subsidence and thermokarst are no synonyms, I'd suggest to remove the term thermokarst given in brackets after (ground subsidence).

p16 ln444: Consider rephrasing to '... measurements show *that* the thermokarst ...'.

p16 ln445: Add space between '100' and 'm'.

p17 ln447: Should read '108 m' instead of '10.8m'.

p17 ln460: Add space between '10' and 'm'.

p17 ln468: Delete 'T. Douglas, unpublished'.

p17 ln471: Rename section heading to '6. ...'.

p18 ln485: Use subscripted number for ' CO_2 ' here and elsewhere in the ms.

p18 In496-497: Please, consider the data policy of the Copernicus journals:
https://www.the-cryosphere.net/policies/data_policy.html

p27 Table 1: Add 'cm' as depth unit to the 'mean' column.

p30 Figure 1: Consider rephrasing to 'Worldview 2 (© Digital Globe) satellite image of the area around Fairbanks, Alaska (*red dot*) identifying the field *site* sites (colored regions) and transects (white lines) in this study.

p31 Figure 2, p32 Figure 3, p33 Figure 4 and p34 Figure 5, p35 Figure 6: Since the 'white line' refers to the transect shown in Figure 1, add 'white line in Fig. 1' in each of these captions. Sub-figures in the caption are identified by capitalized letters and 'non-capitalised' letters in the figure. Please adjust.

p38 Figure 9: Consider fixed scale for the y-axes (temperatures) ranging from -12 °C to 12 °C to enhance the comparability of the nine T plots over time presented here.

p39 Figure 10: In the caption, do you mean '500 km²' or '500,000 km²' as on p5 In 103? Differentiate the combined Figure 10 into (a) and (b) instead of 'left and 'right'. Add scale and coordinates to the Alaska map (a). Here, location names whose data are presented in (b) are barely seen. In (b), consider one y-axis for thaw depth covering all locations presented here and ranging accordingly from 30 to 170 cm thaw depth.

Table S1: Add coordinates of the drill locations. Unfortunately, cryostructures are not described, but probably beyond the focus of this study.