

## ***Interactive comment on “Ground subsidence and heave over permafrost: hourly time series reveal inter-annual, seasonal and shorter-term movement caused by freezing, thawing and water movement” by Stephan Gruber***

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Thank you very much for your review and your constructive comments on this manuscript. I hope that the explanation given below, and the changes to the manuscript, will provide an adequate response.

Referee comments are indicated as “RC” and author responses as “AR”.

RC: I encourage the author to make a short communication exclusively on this topic.

C1

AR: Both referees allude to the possibility of making this a short communication and I respectfully disagree with this suggestion: First, the journal guidelines for (2–4 pages, up to 3 figures/tables, up to 20 references) would not permit an adequate level detail. Second, the potential of processes other than phase change in soil to obfuscate analyses of surface movement can be clearly shown, even with this short dataset and in the absence of additional observations of hydrology.

RC: One of the main unclear points of the manuscript is Figure 4 and the accompanying text, that must be rewritten. In particular, what does 'density' refer to?

AR: Density is better explained now in Figure 4 and also, values have been removed from the vertical axis as they do not add relevant information to the interpretation.

RC: Section 3: Is it possible to add a picture and/or a satellite image of the studied sites?

AR: Both referees asked for an additional image while, at the same time, suggesting shortening the manuscript. As a balance, the revised submission now has an additional figure that shows the character of two field sites (the third being similar to one shown) with overview images and a close-up on the tilt arm showing ground cover. The previous Figure 1 (now Figure 2) has, correspondingly, been shortened by removing the first panel. Because the geographic arrangement is inconsequential and coordinates are listed, no additional map has been included.

RC: Section 4.2 (auxiliary data): Splitting soil temperature data section into a whole paragraph does not seem necessary. Could it be merged into section 4.1?

AR: done

RC: Section 4.8: paragraph not necessary. Could be removed, or used as a small introductory sentence for section 5

AR: removed

C2

RC: Section 5.3: How are defined the thawing and freezing seasons? Soil temperatures, air temperatures, freezing indexes? Moreover, some mathematical notations are unclear, and a few sentences need clarification.

AR: This is explained in the last paragraph of Section 4.7 and the use of soil temperature has now additionally been clarified.

RC: Line122: 'at a distance of 10m or less': I guess it is at a distance of the tilt-arm logger? Please precise.

AR: yes, clarification has been added

RC: Line 172: The wording 'during the time interval  $[t=0,t]$ ' is unclear (and mathematically awkward) : does  $z(t)$  simply denotes the thickness of soil thawed at the time  $t$  ? If so, please remove the sentence 'during the time interval  $[t=0,t]$ '.

AR: yes, clarified by removing  $t$

RC: Line 178: Should not it be 'proportional' instead of 'equal' in  $z = \text{sqrt}(l(t))$ ?

AR: yes, corrected

RC: Line 195: extra parenthesis in the text (Fig.5)

AR: fixed

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Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2019-227>, 2019.