

Interactive comment on “Terrestrial laser scanning for quantifying small-scale vertical movements of the ground surface in Arctic permafrost regions” by Sabrina Marx et al.

Anonymous Referee #1

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General comments:

This paper addresses an important and evolving topic of using terrestrial laser scanning for studying Arctic permafrost. However, I have several questions and suggestions which need to be addressed. I am detailing them below. Nevertheless, the intent and objective behind this work presently are unclear to me and need to be addressed properly. If this work is about methodology development, then I must say that there is very little novelty involved and the advancements in the preexisting approaches are not significant. If this work is about reporting the state of changing permafrost in the Arctic then that part is feebly touched upon, understandably because the changes over a pe-

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riod of just one year would not be as drastic as to definitely comment on the state of the permafrost. It needs more observations. Presently, I feel that although this is a good initiative, this is also a premature reporting and the authors can make a better study by gathering data from more sampling sites and for different seasons over duration of 2-3 years to report on the seasonal dynamics. The highlights of this research need to be emphasized in the present version.

Specific comments:

1. Entire paper needs a thorough language editing in the sentence structures and presentation styles. There is a lot of redundancy that can be avoided.

2. Abstract: It needs modification, particularly in the conclusive lines. The relevance of the research has been mentioned through the four opening lines. It can be shortened. 2-3 more sentences can be added elaborating more on the results, particularly mentioning some quantitative assessments. The end is abrupt and it can be modified by adding a conclusive line that highlights the contribution of the study in filling the research gaps and the future prospects.

3. Introduction:

P1 L23: Add reference for the first line of the introduction.

P2 L3: “. . .allow a detailed. . .” Replace “detailed” by “spatially continuous”.

P2 L25-27: “Such ALS. . .cm”. The resolutions have improved in recent years, particularly with the use of UAV-mounted ALS. So this sentence needs improvement.

4. Study area:

P4 L10-11: Is it the annual average temperature or an average from 1971-2000?

P4 L12-13: How far are the 2 sites from each other? In Figure 1, they appear to be ~100 m apart. As mentioned “Site 1 is about 50x40 m, almost flat and covered by low tundra vegetation and Site 2 is equal in size but contains more shrubs”, I was

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wondering that the sites are so close that they must be having overlapping areas (going by the 50X40 m dimensions and considering that the dots in Fig.1 represent the middle point of the plots). What was the need to keep the sites so close? Is there really any difference in the vegetation as it seems similar for both the sites in Figure 1? I would suggest displaying close-range photos to establish it. These photos should not be only for a single time period for each of the sites but must be consisting of repeat images of the same sites during various surveys so that the reader can visualize the changes in the vegetation.

The legends from fig. 1 are missing. What do the colors in the map represent?

I do not like the fact that although the paper is about a permafrost region, there is not enough description of that in the study area section. Mere citation of a few articles is not enough. The authors must talk about the MAAT and monthly temperatures through some graphs using the data from the nearest monitoring station for past several years to show that the region can still be considered as of having a continuous permafrost. Several close range photos of relevant surface features corroborating the permafrost (for e.g., palsa or hummocks) in the study area could have been added here. This section needs improvement and justifications.

P4, L24-27: "Additionally, . . . environment." This is an extremely important step for repeat surveys. I would have liked to see the pictures of the installed rods. Were these rods marked? How exactly did they serve the purpose of common reference points during the repeat surveys? Did the authors also check for the change in the inclination of the rods during repeat surveys? These points need detailing because it's just a matter of mm scale accuracy and any error in the methodology can compromise the entire results. Presently, I cannot comment on the accuracy standards unless I get the information on this step.

5. Methods:

P6, L9: Full form of OPALS?

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There is no description of interpolation and DEM raster generation algorithms. This cannot be avoided.

6. Results:

P8, L19: NMAD and RMSE are quite high for a TLS-based DEM! Figure 4 represents the poor accuracy of the DEMs.

P8, L23: "change rate" is actually absolute change. How can it be called "rate"?

7. Conclusions:

P11, L20-21: Why is the seasonal subsidence (just 2 months gap) more than the yearly subsidence? If seasonal subsidence is in cm then the yearly subsidence should also be at least in cm and not in mm. The conclusion seems to be consisting of several general points such as multi-point scanning for increasing the accuracy. However, what is seriously lacking is a clear-cut advancement provided by the present research and precise future prospects for studying the Arctic permafrost.

The levels of accuracy achieved during the entire field data collection (table 1, appendix 1) does not seem sufficient to me for commenting on the validity of the results.

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