

## ***Interactive comment on “Vertical movements of frost mounds in sub-Arctic permafrost regions analyzed using geodetic survey and satellite interferometry” by I. Beck et al.***

### **Anonymous Referee #2**

Received and published: 15 May 2015

#### General comments

The paper shows an interesting application of d-GPS in discontinuous, thaw-sensitive permafrost area. The paper addresses two distinct subjects; the first being the application of a methodology to monitor ground surface movement, the second being acquiring new knowledge in regard of the yearly ground surface movement of permafrost mounds. The first objective is addressed by the other reviewer, so we will focus on the second objective of the survey that remains somehow unclear to the reviewer.

Although the technical value is clearly explained, the purpose of the study from a permafrost science perspective is unclear. It is largely due to the fact that the study lacks

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permafrost oriented data allowing reaching the full understanding of the results. We can assume that the question of the active layer dynamic is at the centre of the study; yet it is unclear if the active layer, to which subsidence and uplift movements relate to, has been monitored. What is the thickness of the active layer on the sites? Any idea about what is permafrost thickness too? What were the depths of the thaw fronts at the time of D-GPS measurement? Note: Active layer depth and thaw depth are not the same; the text should be checked to use proper vocabulary.

An easy assessment to do would have been to set up few (one in each type of land cover) inexpensive 4 channel Hobo loggers to monitor the progression of thaw front in the first two meters (we assume that the active layer thickness should be around 1.5 m). Cheap TDR probes are also available on the market, they could have been used to monitor humidity in the active layer; the water supplying ground ice aggradation being a key factor for the uplift. Maybe the CEN would have been of some help in this simple matter. With a least effort, the thaw depth could have been measured using a frost probe at each visit. It is unclear if such data exists (see comment about P 264 line 16).

Some clarifications are required in regard of some climate factors. The addition of one figure (based on fig 4) integrating climate data such as mean monthly air temperature for all the period of the study, and not only the months where the measurements were made, would bring support to authors' interpretations. A snow survey is also missing. Picture of field condition during winter would improve understanding of the results.

The reviewer thinks that the article would have greatly benefited of the missing active layer and climate related data. If such data exist, they should be incorporated. Nevertheless the reviewer thinks that the article is suitable for publication providing clear statement of its limitations in the understandings of the active layer/permafrost processes, and minor modifications aiming to improve both readability and value. Minor corrections are required, such as few missing references to check out.

#### Specific comments

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In 'Abstract' line 1 and 'introduction' line 1: Author should replace 45% of permafrost underlying Canada's land by 40-50%.

P 253 Line 1: "Permafrost ... has a significant effect on the global climate." Should it not be the other way?

P 253 Line 10 – 14: The authors can remark that per nature, ground temperature in these mounds are already warm ( $> -2^{\circ}\text{C}$ ) and therefore predisposed to thaw in a warming climate.

P 254 Line 16: Sheng et al 2004 missing in the reference list.

P 255 Line 22: "mainly scatter". Should be noted "discontinuous"; Widespread or sporadic depending on the location.

P 257 '3.1 Field Data' The paper will benefit if characteristics of the site were summarized in a table. It would lighten the text and would make comparisons easier.

P 257 line 20-21: 'on the east-facing slope' Looks more like North facing to me.

P 259 line 13: 'Few centimeters' 0-5, 5-10, 10-15 cm?

P 261-263 'Results/discussion': The author would greatly benefit to include climate data in their article; a graph showing air temperature record from the CEN's station in the Valley, that allowing temporal comparison between air temperature trend and ground surface movement data seems mandatory, at least a table with monthly average could do the trick. Value for the only months of measurement are insufficient. The reviewer also thinks that even if the question of the vegetation is addressed, the issue of snow is not. Was there more or less snow accumulating during winters 2010 and 2011? How snow may impact the thermal regime of the mound, what is the snow accumulation/topography/wind pattern?

P 261-262 I advise to put Results and Discussion in two clearly identified separated sections.

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P 264 Line 16 "records of the active layer depth" did the authors make a thaw depth survey? If so, why are the data not shown? "nonvegetated areas had very thin ( $< 5$  cm) thaw depths in the summer (August)": is a zero missing (50 cm)? 5 cm seems a bit unrealistic. . .

Reference missing in text: Allard and Séguin 1987 Tait et al 2004.

Technical corrections Fig 6: Letter A is missing (top left)

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Interactive comment on Earth Surf. Dynam. Discuss., 3, 251, 2015.

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