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Interactive comment on "Wind driven snow conditions control the occurrence of contemporary marginal mountain permafrost in the Chic-Chocs Mountains, south-eastern Canada – a case study from Mont Jacques-Cartier" *by* Gautier Davesne et al.

Anonymous Referee #1

Received and published: 31 October 2016

The manuscript by Davesne et al. investigates the impact of snow cover on permafrost distribution in the mountains of south-eastern Canada, focussing on Mont Jacques-Cartier. An impressive data set is utilized consisting of data collected over 4 decades along with more recently collected information on ground surface temperatures (GST). This study complements those done in western Canada in the southern Yukon (e.g. Lewkowicz et al. 2012; Bonnaventure et al. 2012) and in the European Alps (e.g. Gruber and Hoezle, 2001). The paper is fairly well written with the objectives clearly

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articulated. Results and interpretations are effectively presented and the conclusions drawn from these are sound. There are no major concerns with the manuscript and with some minor revisions it should be acceptable for publication.

The paper might benefit from a comparison to some of the work done regarding snow cover and permafrost conditions across latitudinal treeline (e.g. Palmer et al. 2012). Also, much work has been done with respect to permafrost mapping utilizing the BTS (basal temperature of snow) approach in the Swiss Alps and also more recently in northwestern Canada. It might be useful to compare the equilibrium winter GST obtained for Mont Jacques-Cartier to the range in BTS utilized to determine permafrost probability in these other studies. Do you get the same threshold values etc.

Additional comments and suggestions are provided below for consideration in preparation of the revised manuscript. Many of these are suggestions for editorial revisions. The authors also need to check some of their figure and table references. Only a minimal amount of work should be required to address the comments and prepare a revised manuscript.

Specific comments (keyed to line number) L13 – You could mention the type of data utilized in your analysis to demonstrate your hypothesis (rather than outlining objectives in the next sentence).

L15 replace “was” with “were” at end of line

L25-29 – Additional papers that may be relevant here and elsewhere in the paper that have considered permafrost in mountains in western Canada: Lewkowicz et al. (2012); Bonnaventure et al. (2012).

L30-31 – It is not clear here what you mean by snow cover providing a cooling or warming effect. Do you mean if there is little snow, then greater heat loss occurs so surface temperatures will be lower. Also are you referring to the “surface offset” – see Smith and Riseborough (2002)

L41 – revision suggested "..and the spatial extent of . . .." OR say "spatial distribution of permafrost at this site"

L48 – Do you mean surface offset? See Smith and Riseborough (2002)

L71 – Should it be "surface environmental lapse rate"

L91 – Revision suggested ". . .deep temperature cable that has been monitored continuously since 1977.."

L93 – You could say "Early measurements between 1977 and x, indicated . . .." (I assume since you give a range that these are measurements made over a few years)

L94-99 – give temperature at ZAA at beginning of the monitoring period so comparison can be made with the 2013 value. Also why not just say that the temperature at ZAA had risen to -0.3°C by 2013 indicating warming and degradation of permafrost.

L101 – Isn't the impact of snow on GST fairly well known from other studies?

L103 – "measured" might be better word than "monitored"

L110-111 – suggested revisions ". . .probe 350 mc long." ". . .generally conducted in (late?) March or early April.."

L121 – refer to Fig. 1 for location of Petit Mont Saint-Anne

L122 – "determine" might be better word than "measure" since some things are calculated from measured values

L131 – Isn't Lunardini (1981) the original reference for this?

L136 – Domine et al. (2011) is not in reference list – right year?

L142 – do you mean complete melt/disappearance of snow pack?

L144 – Table 2? (gives sensor location)

L147 – Positive air or surface temperature?

L153 – Table 2? Do you mean “beneath a deep snow-bank”?

L162 – suggested revision “. . .on the MAGST was assessed using. . .”

L162-163 – do you mean 2013-14 MAGST?

L170-175 – Did you define the freezing season using the GST and use the same period for summing the air and surface freezing degree days. This is what was done by Karunaratne and Burn (2003). Others (e.g. Lewkowicz et al. 2012) consider the air and surface freezing season separately (i.e. summing freezing degree days over different periods so that for the air this will be the total FDD not just during the period where GST<0°C). You could also cite the CJES paper for Karunaratne and Burn (2004).

L176-178 – Some of the literature related to BTS (Basal temperature of snow) might be relevant here.

L178-179 – Latent heat is also released as the active layer freezes in the fall and winter and this can maintain GST near 0°C – see for example Riseborough and Smith (1998)

Results section – In some places results seem to be combined with background information and some interpretation that might be better in the discussion section.

L200 – suggested revision “..depth was greater than. . .”

L211 – suggested revision “. . .was similar to that observed. . ..”

L222 – Do you mean Fig 5b? Also, you need to label a,b,c on the figure.

L251 – Elevation linked to air temperature, vegetation influence?

L255 – suggested revision “. . .was highly spatially variable. . .”

L256 – You could say there is a range in winter GST of 14°C. Also you should refer to “sites” rather than “sensors”.

L263-264 – Heat is conducted but not temperature. Why don’t you just say that there is limited insulation provided by the snow pack.

L269 – Beneath the snow bank

L289-293 – You probably don't need this.

L297 – replace "was" with "were"

L322 – Can you comment on what this means for GST?

L328- Delete last part of sentence regarding giving names to figs.

L330-355 – You could write in a more passive voice in this section.

L341 – "were" is probably better than "are"; "in" is probably better than "on" L342 – "fluctuated" might be better word

L349 – revise ". . . high values up to 100"

L377 – This short zero curtain might also be related to limited moisture content of the active layer (rapid freeze back and minimal latent heat effect) - see for eg. Riseborough 2001; Riseborough and Smith 1998.

Figures Fig. 2 – Avg for all years? Fig. 3 – These figures are labelled as 1,2,3 so they could be referred to that way in the caption. Fig. 4 – Would it be possible to have a similar type of figure but instead of year of survey you could use veg type/surface cover instead. You could also have a similar figure for GST. Fig. 5 – Label A,B C as this is how you refer to them in the text. Fig. 7 – It would be better to say that this shows the best fit regression line rather than the correlation. Fig. 12 – Correct legend – replace "extend" with "extent"

Other references (not in reference list) for the authors' consideration Bonnaventure, P. P., Lewkowicz, A. G., Kremer, M., and Sawada, M. C., 2012: A permafrost probability model for the southern Yukon and northern British Columbia, Canada. Permafrost and Periglacial Processes, 23: 52-68.

Bonnaventure, P. P. and Lewkowicz, A. G., 2012: Permafrost probability modeling

above and below treeline, Yukon, Canada. Cold Regions Science and Technology, 79-80: 92-106 Karunaratne, K. C. and Burn, C. R., 2004: Relations between air and surface temperatures in discontinuous permafrost terrain near Mayo, Yukon Territory. Canadian Journal Earth Sciences, 41: 1437-1451.

Lewkowicz, A. G., Bonnaventure, P. P., Smith, S. L., and Kuntz, Z., 2012: Spatial and thermal characteristics of mountain permafrost, northwest Canada. Geografiska Annaler: Series A Physical Geography, 94: 195-215.

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Riseborough, D. W., 2001: An analytical model of the ground surface temperature under snowcover with soil freezing. 58th Annual Eastern Snow Conference: 363-372.

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