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Interactive comment on "New ground ice maps for Canada using a paleogeographic modelling approach" *by* H. Brendan O'Neill et al.

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General comments: This paper is an excellent contribution to permafrost science. The importance of surficial geology and the climatic history of the Canadian landscape in determining ground ice conditions is the true key for a modelled mapping of ground ice. The approach is supported by years of data acquisition, geological mapping syntheses and paleo-climate reconstructions by experts at the GSC. The paper makes great progress to the understanding of ground ice conditions over a vast country. A few caveats must be considered for some interpretations. Please find below my comments for improving the manuscript:

P. 2, L15 " Holocene environmental changes results in reduce ice abundance where

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treeline advanced during warmer periods“ . This may not be correct or may need precision. With treeline readvances permafrost patches have thawed (e.g. in palsa and lithalsa fields) but the ice content in the remaining permafrost is still very high. This comment applies in general in the paper. Maybe, you should explain that “ground ice content” in the paper refers to a cartographic value (?), i.e. how much ice content per surface area (??)

P 4, L5. Delete “data”

P5. L-4-9. This methodological approach certainly leads to a great improvement in predictive mapping of ground ice occurence and abundance on the Canadian territory because surficial deposits are the parent material into which permafrost has formed. They are the host materials of permafrost and sedimentary facies regulate the geogryological facies. The pysiographic map of Canada had little relevance to ground ice. I suggest to explain in more details the basic principles used in the expert-system (a technical word to means logical deductions based on Quaternary (Holocene) geological history and climate history through vegetation history), e.g. - Regions of thick glacial deposits that were always in the tundra may still have buried ground ice - Regions of thick glacial deposits that became forested might have had permafrost, but it thawed after forestation. (with possible exception for given climate regions) - Regions of fine grained lacustrine and marine sediments have accumulated abundant segregated ice in epigenetic permafrost - Regions of recent surface sedimentation (Aeolian, fine colluviums, alluvium, organic) have ice rich layer of aggradation ice - . . .and so on.

L9 not clear what is meant by “temporal criteria”

L28-29, Formation of intra-sedimental massive ground ice. You could refer here to the therorical and modellin work of Konrad (1990) in the proceedinds of the 5th Canadian permafrost conference.

P6, L.5, I appreciate the reference to the original (and often forgotten) Taber Paper on ice segregation

L 10, Here I suggest adding aggradational ice at the base of active layer in areas where there is surface sedimentation (alluvium, colluvium, aeolian, organic).

P7, L3-4, I suggest to start the sentence by “Since most of the permafrost in surficial geological materials formed during and after the last glaciation, we model...”

L 10. Precise: emerged (post-glacially uplifted) marine sediments

L11, again precise: “deposited in post-glacial seas”

L16, I suggest adding a sentence: “Indeed, it can be assumed fine-grained matrix-rich tills are more prone for ice segregation than coarsed-matrix tills”.

L17 Precise: “each surficial geology unit”

P8, L9, replace “since” by “but” or by “however”

P9, L10, The ice volume is still very high in palsas, this is a decrease of permafrost area but not of % content in the remaining local permafrost. Avoid confusion between ice content in the permafrost in an area and ice content in a map area (see my first comment in the abstract)

L14, I suggest replacing “melt” by “remnants of relict ice preserved. . .”

L15, frost cracking takes place more in mid winter than in late winter

P10, L 17-18 I cannot make sense of the sentence: “Finally, the present-day permafrost distribution is used to the differential melt of ice-wedges. . .” this needs more explanation.

P 11. L 1, precise: the modelled distribution of segregated ice (your result is a predictive model)

L4 replace “the” by “its”

L7 should you not precise “Early Holocene” ?

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P12, L2, add “in” glacial lake sediments

P13, L 16, spell out the Permafrost Map of Canada (PMC)

P14, L 26-27 be careful here, fine-grained slopewash material, weathered sedimentary rock and fine-grained regolith may contains significant segregated ice. I have even found segregated ice in sedimentary shales on an Arctic Island.

P15, L3-4. I strongly support that the new model better represents distribution of segregated ice in Canada

L17 watch out. The model may fail in wet plains area, where surface drainage is poor, cracking frequent and water available each spring to feed the growth of ice veins and wedges.

L 19. Incipient

L20-25 again in the case of ice wedges: specify: abundance on ground ice in the model means spatial, i.e. amount by surface area, not at all locations.

P16, L12-13 “small units between two larger units were attached to similar adjacent units” incomprehensible technical jargon.

P17, L4 add “full” before complexity

L10, add “overly” before simplified

L26-27 there is another issue with peatlands and permafrost in vast areas where palsas are found: often the minerotrophic peat has accumulated in non-permafrost conditions during warmer early Holocene climate interval. It froze into epigenetic permafrost during Late Holocene (Neoglacial and LIA) cold intervals.

P18, L5 also on some Arctic Island, see Fortierand Allard, The Holocene, on Bylot Island.

P19, L4, replace “may “ by shall

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L9 “updated paleoenvironmental information” : among these are treeline migrations during the Holocene which your model does not seem to consider. They are important for the current distribution of ice-rich permafrost in the discontinuous zone.

Table 1: I Think that low ice content in colluvial deposits is likely an erroneous interpretation. Fine grained ones can be rich in aggradation ice and wedge ice.

Figures: they are great.

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