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Climate of the Past Discussions

Interactive comment on "Climate trends in northern Ontario and Quebec from borehole temperature profiles" *by* C. Pickler et al.

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Climate trends in northern Ontario and Quebec from borehole temperature profiles by C. Pickler, H. Beltrami, and J.-C. Mareschal

Reviewed by Alan E. Taylor, retired GSC

The authors have used boreholes of opportunity in northern Ontario and Quebec with temperature inversion techniques to reconstruct the ground surface temperature history for this area and hence an estimate of climate change over the past several centuries. The present paper is one of a long lineage of similar reconstructions from this group, employing a similar geophysical/mathematical methodology. It is well done.

My main suggestion is that at least a further brief description should be made to the

immediate borehole surface character and subsurface geology, even though this might be more fully covered in the referenced work on these boreholes. Indicate the predominant rock type, possibly with a profile of thermal conductivity that might explain some variations seen in the temperatures. Equations in sec. 2 indicate that conductivity profiles are part of the program input data with the temperature residuals. I assume there is not significant layering except at Nielson where the thermal depth is used to reduce the effect of conductivity variations.

The authors do mention other physical elements or processes that may affect the results (and conclusions?): snow cover or lack of, borehole area vegetation/forest cover and peat, drainage, surface overburden (any?). These might be augmented by the authors' visual observations of the immediate borehole surrounds during logging visits.

For Camp Coulon, the 3 temperature profiles do appear to be distinctly different (Fig. 3). The authors combine such closely spaced holes for an ensemble inversion, a usual practice. But one might wonder if separate inversions would give very different reconstructed temperature histories that might suggest other factors at play (thermal conductivity? Water flow?). Particularly the odd profile at CC1012, compared to nearby holes and considering such precise temperature measurements.

The authors acknowledge indications of subsurface water flows. Presumably (?) the holes are uncased. Could the consistent offsets in temperatures at N1015 ($\sim$300 m), N1013 ($\sim$240 m) and N1012 ($\sim\sim$160 m) possibly result from a sub-horizontal water flow (Fig. 2, Ontario) (e.g., geophysical models of Broedehoeft and others). These holes seem spatially very close (how much?) while N1012 is further south, so perhaps justifying the simultaneous inversion, but also questioning the reason for the differing temperature profiles. Similar offset feature at Eleonore ($\sim$350 m; Fig. 3, Quebec).

Permafrost. This section justifiably has raised issues with other commentators. At the southern margins of permafrost, predicting present or absence of persistent frozen ground is almost intractable even at the local scale: the experiences in Fairbanks,

Alaska bear witness (permafrost conferences). Local-scale, very near surface single point or shallow temperature cables time-series in the sporadic permafrost of the Mackenzie Valley show that surface vegetation, saturation, snow cover may reduce or eliminate the winter cooling cycle (e.g.,Taylor 2000 and similar results in Schefferville – Nicholson and Granberg's work); the topic is covered exhaustively in Zhang et al.'s (2005) work cited.

Maybe better here for the authors to conclude that their GST reconstructions show the potential for permafrost across the region is minimal to absent over the past 5 centuries, with its occurrence highly dependent on surface character and snow cover effects. Suggest add a citation for nearby locations, if any, where permafrost has been documented.

Small point: the temperature scale ranges vary through Fig. 2 and 3 but the sensitivities are consistent; it would be useful to indicate that in the caption as it makes for inter-comparison; same for Fig. 4-6. A few editorial suggestions are on an annotated copy of the PDF manuscript.

Please also note the supplement to this comment:
http://www.clim-past-discuss.net/cp-2016-55/cp-2016-55-RC2-supplement.pdf

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