

Review Pendleton et al. (2017): Episodic Neoglacial expansion and rapid 20th Century retreat of a small ice cap on Baffin Island, Arctic Canada and modeled temperature change. *Climate of the Past*, doi:10.5194/cp-2017-27.

### **General Comments.**

This is an interesting paper and presents an interesting data set of radiocarbon dated plant material along a transect from a glacier margin to evaluate the advances or recessions of that margin over time. This is a well-established method that is (unfortunately) becoming more and more common as glaciers are disappearing around the world.

However, I cannot recommend publication of the manuscript in its present form. First, the paper contains many assumptions and statements that are not adequately explained or supported by the presented evidence as detailed below.

Second, I'm concerned that the Supplemental Information containing the model description is actually longer than the manuscript itself and contains a lot of explicit and implicit assumptions (as well as some key results presented in Section 5.3) that are not adequately explained or discussed, for example:

- It sounds like you are effectively tuning your model to the transect chronology and (assumed) maximum LIA extent using the solar radiation melt factor, but then you argue that your model to reconstruct patterns of ice expansion - isn't that circular reasoning?
- What about the other factors and parameters of your model that are unknown such as the degree-day factor (is that one for snow or ice or both?) or the lapse rate? Presumably you could combine a variety of factors / values and get similar fits to the observations (SI, Figure 3).
- As I understand it, superimposed ice formation is an important factor in the mass and energy balance of these types of ice caps and should be included in the model.

I'm certainly not an expert in glacier modeling, but it seems to me that this manuscript should be reviewed by such an expert in order to make more confidence in Section 5.3 (see below). Much of the material included in the Supplemental Information should be included in the manuscript itself (e.g. Section 4.2).

A similar argument applies to climate/glacier model comparisons in Section 6.3. The methods underlying this section are presented in the Supplemental Information and include a series of steps and assumptions that are not adequately explained and defended.

Section 5.2

It seems like sample #12 is critical as it defines the ice expansion ~ 2 ka and continuous ice cover until a few years ago. First I would not call it the southern margin - the sample seems to be from the western edge of a small outlet glacier. Is it also possible that snow and ice persisted in this (maybe topographically-sheltered?) location while the remainder of the ice margin behaved differently?

In line 12 you argue that for a specific type of ice advance: a) how does your data show that and b) why is that relevant?

Line 20 / Figure 3: Why are you plotting the ages of the dead plants against elevation - isn't more common and appropriate to plot against distance (e.g. distance from 2015 margin)? Some of elevation changes are quite small and well-within typical GPS uncertainties.

Figure 3: What is the relevance/meaning of the data shown on the secondary y-axis and how does the data support your analysis? This may be obvious to you, but not necessarily to the reader.

### Section 5.3

I'm confused here. It seems from the text in Section 5.2 that the ice cap in 2014/2015 was more-or-less the same size as it was 2,000 years ago as defined by Sample #12. Figure 3 shows to me that the ice cap margin at 1,000 CE was more-or-less at the same elevation as today at ~1185 m asl. Therefore it is not clear why the 0.19 deg C cooling is needed? Figure 3 shows that the ice cap advanced to its (assumed) LIA maximum (~1240 m asl), so the 0.25 deg C makes more sense. A table summarizing the different different temperature changes for the different dates would be helpful.

Page 6 / Lines 4 to 11: These values (e.g. 0.028 deg C / year) should be derived and explained in the main manuscript, not in the Supplemental Information. There also seems to be a discrepancy in the amount of cooling it took to grow the ice cap from 1,000 CE to its LIA maximum (0.25 deg C) and the warming that caused the ice cap shrink from its LIA maximum to today (2.8 deg C). A summary table as suggested above might clarify the issue.

Page 6, Lines 12 to 15: This is a weak paragraph. Why do the model assumptions translate to minimum values for temperature changes? Explain and defend the model limitations and uncertainties. For example - present a series of charts showing the ice margin elevation under changing model assumptions and parameters.

### Section 6.2

This section is confusing - important methodological steps and considerations are only included in the Supplemental Information and should be part of the main manuscript. It seems like much of the issue revolves around splicing a model simulation starting in 850 CE to a model simulation that has currently only reached 1270 CE using a simple offset. I suggest waiting for the model simulation to finish or to cut-out this section.

### Specific Comments.

1. What 'happened' before 20 BCE? Discuss the overall Holocene history of the ice cap as context for the last 2,000 years, perhaps in Section 2.

2. Page 3 / Line 18: That's the standard assumption - a vegetation trimline defining the maximum LIA ice extent, but is there actually any evidence for it? How do you know that? Could it be, for example, perennial or long-lasting seasonal snow cover, especially in what appears to be a topographic setting conducive to the persistence of snow? See also Page 6 / Line 19 and 20: you have not shown that in the manuscript

### **Technical Corrections.**

- Page 2 / Line 18: Also include an existing reference/citation here in addition to the 'in-review' one.
- Page 3 / Line 14: Is that an official name?
- Page 5 / Line 7: a post-bomb age - what does that mean?
- Page 7 / Line 3: Reword the sentence - the word 'strong' seems not appropriate here.
- Figure 1: Draw the trimlines into A - they may be obvious and prominent to you, but not necessarily to the reader. The image used seems 'fuzzy' - what's the source of the image (should be included in the caption). Add a scale to 1B and 1C.
- Figure 2: Can you indicate the approximate photo locations on Figure 1B?
- Figure 3: Label the blue circles with the Sample # from Table 1.
- There are many other minor typos and stylistic inconsistencies throughout the manuscript and especially the Supplemental Information.