The authors and I would like to thank the anonymous Reviewer #1 for their comments and suggestions on the submitted manuscript. Here, I would like to respond to and provide additional details on the Reviewer comments (chronologically).

General comments:

- In terms of model calibration, knowing that our glacier simulations must fit the transect chronology provided by the plant radiocarbon ages and the LIA maximum extent delimited by prominent trimlines, we adjust the solar radiation melt factor to attain the best fit scenario. The primary purpose of the glacier simulations is not to reconstruct ice margin activity (this is already known from our transect chronology), but rather to use the known chronology within a mass-balance driven (and thus climate driven) glacier model to approximate the necessary temperature changes required to reproduce the observed glacier activity over the past ~2000 years. Yes, the model does reproduce the observed ice margin activity, but the end purpose of the model is to determine the temperature change driving ice advance and retreat over the past ~2000 years. This is clearly laid out in the beginning of section 5.3. However, the text in lines 24-25 in the abstract is ambiguous regarding the end purpose of the modeling experiments. We think that rewording of text in the abstract to more closely match that in section 5.3 would help to clarify the purpose of the modeling.
- The degree-day factor from Braithwaite (1981) is empirically derived from summer ablation data taken from four glaciers in the Canadian Arctic and is the most appropriate value to use given the location of our Divide Ice Cap (see Cuffey and Paterson, (2010) for a more recent discussion). With regards to lapse rate, Gardner et al. (2009), working on glaciers in the Canadian Arctic, found that the moist-air adiabatic lapse rate can differ significantly from the lapse rate measured near glacier surfaces, hence our use of their slightly lower glacier-surface lapse rate of 4.9°C km^{-1}.
- Super imposed ice (or refrozen melt water) is thought to be an important component of mass balance, especially for polar glaciers. However, even though refrozen melt water can account for up to ~20% of annual accumulation (Wadham and Nuttall, 2002), it can vary significantly due to percolation and drainage flow paths (Cuffey and Paterson, 2010). Zwinger and Moore (2009) used in situ observation data to attempt to capture the effect of refreeze both in terms of accumulation and heat transfer. However, lacking any such data for DIC, attempting to model such a process would only introduce additional assumptions and uncertainty. Field observations of the ice cap showed numerous supraglacial meltwater channels and no obvious signs of large scale refreeze, suggesting that DIC may shed meltwater efficiently, reducing the impact of super imposed ice.
- The authors originally decided to place a majority of the modeling into the supplemental to maintain a short and concise manuscript, but we agree with the Reviewer that moving some of the modeling material into the manuscript could be useful. The authors defer to the editor's judgement about relocation of supplemental material within the manuscript.
- Regarding the climate/glacier model comparisons: the submission deadline of Feb 11 for the special issue prevented us from waiting until the CESM climate model had finished its run, hence the composite with the LME simulations to get the full 2000 year temperature record. The CESM simulation has since reached 2005 CE, allowing us to compare our temperatures derived from our glacier model directly to the CESM run. The

supplemental section on compositing the two climate simulations can now be removed entirely.

- I agree with the Reviewer than sample twelve is more westerly than southerly, will be changed in a revised manuscript. Given the low topographic relief around the summit of the ice cap, shielding/shading is negligible, and the ice margin at sample #12 should behave in concert with the rest of the ice cap.
- In line 12 we argue for episodic ice margin advance based on the spatial and temporal distribution of plant kill ages. Each plant kill age represents the time when the ice margin advanced *through* that location; the kill ages don't necessarily represent a standstill like a moraine might (it is possible, and likely, that the ice margin was not continuously advancing, but our kill ages only record times of ice advance). For example, the distribution of samples #1-4 suggest that the ice margin advance rapidly (a few decades) from 1185 to 1198 masl, but then advanced to 1205 masl over a period of ~200 years, which requires, at a minimum, a change in the rate of ice advance (if not a standstill), hence the conclusion that ice margin advance is episodic in nature, with periods of faster and slower ice margin advance. We agree that this is not clearly laid out in the manuscript and text to clarify will be added. This episodic nature is relevant because one could argue that the systematic decrease in Northern Hemisphere insolation during the Holocene should drive continuous cooling and glacier expansion, but here we are seeing gradual ice cap expansion punctuated by episodes of fat ice advance, suggesting that other mechanisms are involved in the late Holocene climate evolution.
- We agree that the age/elevation plot in Figure 3 is not as common as age/distance plots. However, given the steep topography of the saddle where the samples were collected, the plant kill ages are tracking the inflation of the ice cap uphill. The authors determined (after much deliberation) that the age/elevation plot was more representative of the ice margin activity in this case. Vertical GPS uncertainties can be added to a revised plot.
- The secondary axis in Figure 3 is a normalized PDF of ice margin plant kill ages from the Cumberland Peninsula region which shows periods of regional ice margin advance. The agreement between this record and the transect of plant kill ages supports the conclusion that our periods of accelerated ice margin advance are occurring during periods of increased regional ice expansion (and therefore cooling). This is perhaps not well explained in the text (section 5.2) and text will be added to clarify this conclusion in a revised manuscript.
- As of summer 2014 (time of sampling), sample #12 was exposed, and its age suggests it had been ice covered for ~2000 years. As of 2015, the ages of samples #1-4 at the 2015 ice margin suggest they had been ice covered for ~1000 years. It is important to note that ice caps do not advance and retreat symmetrically. The modern ELA is everywhere above the elevation of the ice cap, so rapid retreat is exposing both areas that have been ice covered for ~2000 and ~1000 years simultaneously.
- The 0.19°C and 0.25°C drops in temperature are derived from the glacier model. The plant kill ages spatially and temporally constrain the position of the ice cap over the past ~2000 years. In order to conform to these constraints, the average temperature between 0-1000 CE must drop by 0.19°C (relative to pre-0 CE temperatures). In order to conform to the plant kill age chronology between ~1000-1900 CE, an additional drop in average temperature of 0.25°C is needed in order to advance the ice margin to the correct location in the allowed time interval.

- Page 6/Line 4-101: I agree that some or all of the supplemental regarding the rates of warming could be moved in to the main text to clarify how warming rates were derived.
- The reversal from slow cooling during the period ~1000-1900 CE, to rapid warming in recent decades is not a discrepancy, but rather further evidence that modern warming is well outside the norm of at least the last ~2000 years. This is actually an important conclusion of the study (see Conclusions), but is not as clearly laid out in section 5.3. A small table showing the different periods and the associated temperature changes can be added to the section.
- Page 6/Lines 12-15: A clarification here, since the glacier model is forced by stepwise temperature changes, the model reports the average temperature required to advance the ice margin over the required distance in the allotted amount of time. A figure showing the glacier model under various parameter values was originally placed in the supplement, but removed for space. Such a figure and text could be added to the manuscript or the supplement to detail how the model varies.
- Per our comment above, the CESM temperature simulation to which our data is compared has now run up to 2005 CE, allowing us to compare to the full run instead of the composite temperature in the current record. This significantly simplifies section 6.2.

Specific Comments:

- This manuscript was submitted for consideration into a special PAGES2ka issue regarding the last 2000 years of climate change in the Arctic, hence the authors focus on the late Holocene. Work elsewhere on Baffin suggests glaciers were regrowing as early as 5ka, but our data do not speak to ice activity prior to 2ka. Give the age and position of sample #12, it is likely that the ice cap was behind the sample location but growing in the decades to centuries prior to 20 BCE (before expanding through sample site #12). Section 2 provides general Holocene glacial activity on Baffin. This study is the first to look at the late Holocene activity of this particular ice cap. Do you perhaps mean the history of the Penny Ice Cap over the past ~2000 years?
- Page 3/Line 18: The uniform nature and clarity of the trimline suggests it is the LIA ice margin. A perennial snowline would not be as uniform in elevation or clarity. The southerly aspect of this slope would also limit snow cover. Finally, the radiocarbon ages approaching the trimline also indicate LIA timing.

Technical corrections:

- Page 2/Line 18: Pendleton et al. (2016) also deals with moraine degradation and scatter in CRN ages.
- Page 3/Line 14: Divide Ice Cap (DIC) is an informal name; noted in text.
- Page 5/Line 7: A post bomb ^{14}C age is one that dates to post 1950 CE (after nuclear weapons testing loaded the atmosphere with more ^{14}C). See Reimer et al. (2004) for more information.
- Page 7/Line 3: replaced ‘strong’ with ‘convincing’.
- Figure 1: quality of figure checked (fuzziness due to upload issue). Trimlines added to panel A. Scales added to B and C.
- Figure 2: Camera location can be added to figure 1B.

- Figure 3: Sample #s from Table 1 added to blue circles.
- Manuscript will be thoroughly edited for grammatical and syntax errors during revisions.

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