Clim. Past Discuss.,
https://doi.org/10.5194/cp-2020-66-AC2, 2020

Climate of the Past Discussions
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EGU

Interactive comment on "Glacial history of Inglefield Land, north Greenland from combined in-situ ^{10}Be and ^{14}C exposure dating" *by* Anne Sofie Søndergaard et al.

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Received and published: 21 July 2020

We have addressed all comments and suggested changes to the manuscript and our responses and following actions are outlined below.

Detailed comments:

Methods and Tables 1/2: What were the lithologies of the boulders sampled for 10Be? Were they consistent with the local bedrock (or likely far-traveled from inland under the ice sheet)?

Answer: We have added a couple of lines in the Methods section about the lithology

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and our interpretation of transport distance.

(And in Results, any pattern of different lithologies among the oldest vs youngest 10Be ages, ie degree of inheritance?) Or is everything uniformly granitoid/ gneiss with local vs exotic provenance impossible to pin down?

Answer: Everything is uniformly granitoid/gneiss. We have looked into possible patterns between the lithology and inheritance, especially Feldspar (Al) content in the samples, but there is no clear pattern between ages and lithology. We have added a comment in the results section (4.1) about this.

Please describe further the morphostratigraphic contexts of the dated wood fragments. Were they exposed on the surface of the meltwater plain, coming out in meltwater right at the ice front, or found buried in an outcrop of river deposits?

Answer: The wood fragments were collected together with samples presented in recent studies concerning the Hiawatha Impact crater (Kjær et al., 2018; Garde et al., 2020). We have added more information on the sample site in the methods section 3.2.

Any evidence for the species of the “wood”?

Answer: It has not been possible to identify the dated wood found in front of the Hiawatha Glacier.

It would be useful to include any information that rules out or argues against these materials having been exhumed by water or wind from a nearby soil (instead of excavated by ice inboard of the present-day ice sheet margin, as is inferred). This possibility should be discussed in the Results and/or Discussion as well.

Answer: We have commented on this in the results section 4.2, where we argue for our interpretation of the wood fragments having originated from underneath the glacier.

There is a brief description of context for the 14C-dated molluscs (on and within diamicts), but it appears in Results and I suggest putting this fundamental sampling

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information in Methods.

Answer: This information has been moved so it now appears for the first time in the methods section.

Line 273: “the ice margin reached its present-day extent at Delta Sø c. 10.1 ka” The age of 10.1 ka is actually the basal age from Wax Lips Lake, which is indeed the best constraint on when ice in that region reached its modern extent because WLL is situated only _2 km from the modern ice margin (McFarlin et al 2018 PNAS, discussed in Axford et al. 2019). Suggest changing “Delta So” in this sentence to “Wax Lips Lake” and citing McFarlin (and add WLL to Fig 8a if needed).

Answer: The sentence and reference have been changed as suggested and the location of Wax Lips Lake has been added to figure 8a.

Line 284: “Farther north in the Thule area and around Qaanaaq, mosses from a local ice cap and subfossil plants from the GrIS show a smaller ice extent before c. 3.3 cal. ka BP (Farnsworth et al., 2018; Axford et al., 2019: : :” Just a note that Axford et al. also find the North Ice Cap was smaller than present for most of the Holocene, as reflected in your Fig 8c, and that seems to contrast with the wording here.

Answer: The 3.3 cal. ka BP is linked to the study around Qaanaaq - we have rephrased the sentence for clarity so it now reads: Farther north, mosses from a local ice cap and subfossil plants from the GrIS show a smaller than present-day ice extent before c. 3.3 cal. ka BP around Qaanaaq and throughout most of the Holocene until c. 1850 AD in the Thule area (Farnsworth et al., 2018; Axford et al., 2019; Søndergaard et al., 2019).

Line 299: I think it is debatable whether the early Holocene peak warmth in NW Greenland was “earlier than in the rest of Greenland.” What is the evidence for later onset of warmth everywhere else? There is some evidence for early warmth in the east, including from Renland ice cap (which unlike most of the central Greenland ice core records

and I think the very nice Buizert work, is elevation-corrected). Suggest just removing this statement that generalizes across all of Greenland, and keeping your discussion focused on the evidence for timing of warmth in the Nares Strait region vs a bit further south in NW Greenland, as you already mostly do. Answer: We have deleted the statement as suggested.

Also, given the dearth of diverse evidence for atmospheric temperatures themselves in the Nares Strait region, it would be interesting to see a more fleshed-out discussion of the possible climate interpretations of the ice sheet history. Is it possible that the ice margin history is somehow compatible with early Holocene peak temperatures (more sensitive to ocean temperatures, longer lag in ice sheet equilibrium, more sensitive to precip??), or does the ice margin history truly preclude that?

Answer: We have added a part in section 5.4 about the possible effects from the Innuitian Ice Sheet on the western north GrIS during early Holocene. Following these lines, we already commented on the effects of rising temperatures and the opening of Nares Strait on the north GrIS margin and its retreat.

Figure 9: I don't think I've seen ice margin histories summarizes in quite this way visually before, and I really like it! Useful way to represent the data across a range of studies.

Answer: Thank you!

General point on the Discussion: One major conclusion of the cited Reusche study nearby is that the ice margin responded to cold events _9.3 or 8.2 ka, interrupting rapid retreat in the early Holocene. That should probably be acknowledged and discussed at least briefly. Do the new data generated in the current study add to or modify that picture?

Answer: In section 2, Study site and previous work, we briefly mention the study of Reusche et al and the possible stillstand of the ice sheet at 8.2 ka. Further, in section

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5.2, we discuss the exposure ages from Humboldt Glacier in connection to the study from Reusche et al: Farthest north in Inglefield Land, at the southern flank of the Humboldt Glacier the ice margin reached its present-day extent already by c. 8.2 ka (Fig. 7a). This age is consistent with the 10Be chronology from the northern flank of Humboldt Glacier where a moraine a few hundred meters outside the LIA moraine was abandoned c. 8.3 ka (Reusche et al., 2018). We have therefore not added anything further to the text about this.

Discussion, _line 310 etc: While invoking ocean temperatures to drive mid-Holocene minimum ice extent, it is also worth noting that many paleotemperature proxies from Greenland and Agassiz indicate that air temperatures were elevated above those of the late Holocene and even the 20th Century well into the middle Holocene. Could the minimum ice extent in the mid Holocene alternately represent a lagged equilibrium with warmer-than-20th C temperatures?

Answer: We believe that the rising sea surface temperatures in middle Holocene were the main driver of the smaller than present-day extent of the ice sheet in northwest Greenland. But it is likely that warming sea surface temperatures boosted a trend already happening from high atmospheric temperatures. We have added a few lines to section 5.4.

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