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Climate of the Past Discussions

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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This paper presents new 10Be and in situ 14C constraints on the timing of early to middle Holocene deglaciation of Inglefield Land in northwest Greenland, and 14C ages from reworked organic materials that record a period in the middle to late Holocene when the Greenland Ice Sheet in the study area was smaller than present. The combination of 10Be and in situ 14C reveals extensive nuclide inheritance in the region, indicating past cold-based ice cover / mimimally erosive ice, especially on highlands. The paper thoughtfully integrates all data types to reconstruct the ice sheet margin history in an area where more data are badly needed. And I appreciate the review of

prior work to piece together a broader picture of regional glacial history. Altogether, the paper documents some regional coherence as well as complex spatial variations in the timing of glacier margin changes, and those patterns should ultimately – in concert with future work to flesh out the paleoclimate and/or glacial history in even greater detail – help our community understand key aspects of ice sheet dynamics. I enthusiastically recommend this study for publication after minor revisions. It takes a thorough, multi-method approach to fleshing out the glacial history of a poorly known sector of the Greenland Ice Sheet.

My most significant suggestion is to better describe the morphostratigraphic contexts of the 14C-dated organic materials, and in the case of the wood fragments the rationale for inferring that they derive from inboard of the modern ice sheet margin. I think the link between minimum ice sheet extent in the middle Holocene and the inferred driver of ocean climate (vs. atmospheric), could also be further considered and further justified.

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)? (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?

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? Any evidence for the species of the "wood"? 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.

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 information in Methods.

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).

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.

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. 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?

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.

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?

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?

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