Clim. Past Discuss.,
https://doi.org/10.5194/cp-2020-57-RC2, 2020

Climate of the Past Discussions
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EGU

Interactive comment on "Younger Dryas ice-margin retreat in Greenland, new evidence from Southwest Greenland" *by* Svend Funder et al.

David Roberts (Referee)

d.h.roberts@durham.ac.uk

Received and published: 25 June 2020

General comments

This papers present some new deglacial ages (10Be) for the SW coast of Greenland. Some of those ages suggest that ice had retreated to the present coast prior to, or during the YD, though problems with inconsistent/inherited cosmogenic radionuclides make the construction of robust regional ice sheet history challenging. Many other deglacial age estimates along this coast (10Be and 14C) suggest deglaciation between 11.5 and 10.5 k, and an alternative approach (the incorporation and combination of the new chronological data with other local deglacial records) would have produced a different (younger) range of deglacial histories for the coast. Hence, the arguments

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relating to YD ice extent would have been somewnat different to the conclusions made in the paper.

The discussion element of this paper provides a useful review of the possible extent of the GrIS pre and during the YD, and assesses some of the driving mechanisms (oceanic and atmospheric) that may have driven GrIS oscillation. However, the first part of the paper, the deglaciation of the SW sector of the GrIS, becomes divorced from the later 'review ' element of the paper, and given the problems with inheritance and the mismatch with other coastal deglacial ages this needs to be addressed.

Specific comments

Abstract: The abstract would benefit from more detail relating to the present study. Why is the GrIS margin being situated on the inner shelf unexpected? As is demonstrated later, the position of the GrIS margin during the YD is poorly constrained in Greenland, but ice has often been shown to be on the inner shelf/near coast during the YD.

Li 39: 'During the YD the GrIS in most areas had its margin on the shelf' ..... this contradicts the abstract.

Li 40: What is the rationale behind choosing these six sites in the SW? What are the key aims of this paper - to provide a detailed analysis of these new sites, or to provide a review of the YD in Greenland? The paper is more focussed on the second of these aims and is unbalanced because of this.

Li 51: 'younger stratified aquatic sediments'. . ..please provide details.

Li 60-64: Based on pre-existing work (10Be/14C) the retreat of the ice to the coast is fairly well constrained to 11.5 to 10.5ka. The new sites are effectively also at the coast. At best they will reinforce our knowledge of the timing ice retreat to the coast but how will they help with the YD question? Ideally, you really need offshore cores and 14C samples to answer the YD question.

Figure 1(b) does not provide enough detail on the location of the sites. Add a more

detailed map. Perhaps split the area north and south. Spatially (a few km's), many of these sites are at the coast and very close to pre-existing sites that have been dated. Do they provide the necessary lateral extent to effectively differentiate deglacial ages?

Li 130-132: 'therefore consider a spread of old ages as "inheritance outliers", while the mean of clustered younger ages gives the most reliable deglaciation age'. Inheritance does cause problems, not least because all the samples could be affected by inheritance and it cannot be quantified in any of the samples. Perhaps a more statistically robust approach to this (e.g. Jones et al. 2019 or Roberts et al., 2020 - Uncertainty weighted means/Chi-squared/extreme studentised deviation test) would provide an alternative framework for assessing the outliers?

Have the author also thought about combining their new data with pre-existing ages to provide more robust local datasets. It's a question of the lateral extent (spatial) and rate of retreat (temporal), but it is worth considering and could provide an alternative framework for deglaciation (to compare against).

Li 136- 148: Buksefjord - deglacial age of 12.3 $\pm$ 0.2 ka in mid-Younger Dryas (based on two ages) – this is much older than all other reported sites locally (10.7 to 11.4 ka). So, this could be inheritance, or deglaciation in the skaegaard (where is this?) indicates that the fjord glaciers lingered in their troughs while the adjacent coastal areas became ice free - the uncertainty makes it difficult to know which.

Li 149-160: Fiskenæsset deglaciated at 13.3$\pm$ 0.5 ka – a robust set of samples that point to pre YD deglaciation. Local deglaciation previously reported at 10.6 - 10.5 ka. 'Even though these ages are minimum constraints for deglaciation, it is not likely that they postdate the deglaciation of the outer archipelago with 2000 years. This indicates that also here the major outlet glaciers reached the inner shelf, while adjacent areas had been ice free for some time'... Please explain this concept further for the benefit of the reader, as their does not seem to be any evidence presented to support this statement.

Li 162 – 169: Ravns Storø – a mixed set of ages with the two youngest providing an age of 11.7±0.2 of deglaciation (post YD).

Lin171- 177: Avigaat - A large spread of ages 13.7 ± 1.1, 12.0 ± 0.5 and 10.3 ± 2.5 ka giving an average of 12.0 ± 1.6. A local 14C age of provide an age 11.3 cal. Kyrs BP (possible mid YD deglaciation, but his is very poorly constrained).

Li 179 – 193: Paamuit – deglaciation at 12.2 ± 0.2 ka (robust set of ages) ice-margin retreating from the inner shelf in mid-Younger Dryas. This probably overlaps within error with the Kuanersoq age of 11.7 ka (please clarify), though 12.2 ka is older that other local deglacial ages (11.2 – 11.0 ka). 'we suggest that an ice stream in the Kuanersoq trough remained at the inner shelf while the adjacent coastal areas became ice free'. Based on the site descriptions provided and figure 1 it is very difficult for the reader to follow or substantiate this.

Li 195 – 204: Sermiligaarsuk deglaciation at 10.9 ±2.3 ka based on one date. Only one other local deglacial date (9.7 cal. ka BP) - post YD deglaciation

It is worth noting that all these sites are essentially at the present coast. None of them give a consistent pattern for the timing of deglaciation from the inner shelf to the present day coastline. So, it is very difficult to make inferences about the behaviour of the GrIS pre or during the YD. What would happen if these new ages where averaged with other local deglacial ages? It would give a very different picture.

Discussion

Li207-225: There is some evidence here to suggest ice withdrawing from the inner shelf pre or during the YD, but the 10Be ages are inconsistent. The arguments relating to ice steams sitting in the troughs later than the peripheral interstream areas along the coast makes glaciological sense, but is not really substantiated in any way in this paper.

Li227 – 248: This section provides a good overview the deglacial history of some other

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sectors of the ice sheet during the YD.

Li 250- 282: Moraines on the outer to mid shelf (Hellefisk and Fiskebanke). This part of the paper provides a brief review of the possible age of the moraines on the shelf and concludes they pre date the YD and where formed in response to a range of climatic and non-climatic forcing factors. But this is stepping in to a different set of questions with respect to the behaviour of the GrIS and is becoming divorced from the original focus of the paper. These are mid to outer shelf moraine systems that formed pre YD. They are not directly related to the coastal deglacial story that form the basis of the paper.

Li 284 – 336: The third section of the discussion highlights a number of discrepancies with respect to the dating of GZW's on the continental shelf around Greenland. Those that have been dated (14C) often infer pre YD formation, but other several recent studies have speculated that many mid –shelf GZWs could be YD in age based on "climate-correlated" records. I think many researchers will agree that the second approach is flawed. This section is essentially a mini review of the dating of GZWS on the continental shelf, but it is only partially linked/relevant to start of this paper. I am not sure what this paper wants to be - a review paper?

Li 338 – 365: The last section (5.5) of the discussion provides a review of possible forcing mechanisms for deglaciation of the GrIS on the continental shelf during early deglaciation through to the YD. Ocean forcing and increased seasonality with respect to summer/winter air temperatures are discussed (cold, arid winters + increase in sea ice v warmer summers). This explains why ice was largely undergoing retreat pre YD and during the YD (despite the ice core records showing regional cooling during the YD). These are really important issues when it comes to understanding GrIS response to climate change, but again this discussion is largely divorced from the study at the start of this paper (deglaciation of the SW coast of Greenland).

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