

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

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General Comments

This manuscript presents a new cosmogenic ^{10}Be chronology for Greenland Ice Sheet (GrIS) retreat from an archipelago of outer islands off the southwest coast of Greenland. Surface exposure dates from these locations help to constrain the timing of retreat off the continental shelf, with ^{10}Be concentrations suggesting retreat occurring during the mid- to later-Younger Dryas (YD). While this apparent retreat at face value presents a conundrum for ice sheet forcing (cold atmospheric forcing should drive ice sheet advance), the authors explore a variety of possible explanations for retreat, including melting of the ice front by warm subsurface ocean currents and the recent

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suggestions that enhanced seasonality during the YD may obscure warmer summer temperatures in annually-average temperature reconstructions (Note: the short comment already posted by Richard Alley suggests that the authors may also consider the finer detail in the ice core data across the late-YD).

In addition, this dataset presents an important constraint on the timing of GrIS retreat from the continental shelves. The locations of these surface exposure dates are significantly proximal to the GrIS in comparison to the underwater moraines and grounding-zone wedges, which were previously inferred to be YD in age. This suggests that the ice sheet was significantly smaller during the mid- to late-YD than previously thought, which implications for estimates of ice volume evolution throughout the deglaciation.

Given the novel location of this chronology and the implications for ice sheet forcings during the Younger Dryas, I believe that this manuscript is worthy of publication. The authors provide a nice description of ice margin dynamics during the YD, and I appreciated reading their extensive survey of the literature throughout southern Greenland. However, I am concerned about the sampling of bedrock and the potential for inheritance. The authors work to address these concerns, but I believe the some of the conclusions may be overstated, given the possibility that many of the reported ages may still provide a surface exposure timing that is too old for the true timing of deglaciation.

Specific Comments

Inheritance – The existing “interactive comment” from Nicolas Young lays out many of the important concerns that I share on topic of inheritance. In many applications, bedrock samples are prone to inheritance due to insufficient subglacial erosion to reset the cosmogenic clock (Bierman et al., 1999, *Geomorphology*; Colgan et al., 2002, *GSA Bulletin*; Corbett et al., 2013, *GSA Bulletin*; Briner et al., 2016, *GRL*). And since each site presented in this paper only has 3 samples, it is difficult to ascertain outliers (either too-old or too-young). The two sites with boulder measurements (Ravns Storo and Sermiligarsuk) make this concern clear, with boulder measurements significantly

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younger than the neighboring bedrock (although at Ravns Storo, 1 out of 3 bedrock samples does line up with the boulder sample). Additionally, each of these sites with boulder/bedrock pairings only have one boulder sample, which also precludes assessment of the efficacy of these boulder samples alone, even though they appear to be consistent with some of the neighboring 14C chronologies. I recognize that the authors state that boulders were generally not present, so I do not mean to suggest that more samples are necessary when more samples are not available. However, I think the conclusions about mid-YD retreat should not be overstated without acknowledging that some of the final exposure ages may still be too old (i.e. the bedrock ages provide a “maximum” age). For example, on line 221, the authors write “the results show that the ice sheet margin in the area WAS retreating on the inner shelf during YD”. I suggest being careful with language of absolute causality here (“...in the area MAY HAVE BEEN retreating. . .”) and throughout the paper.

Mid-YD retreat – Out of the 6 sites presented in this paper, it appears that only 3 suggest mid-YD retreat (Buksefjord, Avigaat, and Paamiut). In addition, the exposure age of Avigaat includes a rather large range of uncertainty that actually spans the entire YD, and therefore does not provide a robust constraint for before, during, or after YD. Again, coupled with concerns about inheritance, I continue to think that the conclusion about mid-YD retreat is overstated.

Lack of YD readvance (mentioned throughout, e.g. lines 246-248, 280-281) – Could you be more explicit on what types of evidence (or lack thereof) suggest that ice did not readvance during the initial YD? If the possibility of inheritance exists at some (or all) of these sites, couldn't the Fiskebanke moraines still potentially be YD in age, thus providing the evidence for a YD re-advance?

Evidence for warm-based ice - Of particular concern related to the topic of inheritance is whether or not ice was sufficiently erosive to reset the cosmogenic clock on the bedrock surface. In particular, previous studies have suggested there to be minimal glacial erosion at fjord mouths on Baffin due to ice thinning and spreading (Briner et al.,

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2006, Geol. Soc. Am. Bull.). I wonder if the authors could provide further description of the sampled surfaces. For example, documented presence of striations and glacial polish would indicate basal sliding. Given the concerns about inheritance, being able to document warm-based ice conditions would help provide some indication that this landscape experienced “some amount” of glacial erosion prior to exposure. In addition, the evidence of striations and glacial polish would suggest minimal post-glacial erosion (which would bias exposure ages to be too-young; the authors assume zero erosion in their age calculation).

Line 131 – the youngest bedrock sample is considered to be a “minimum age”. Given the potential for inheritance, I am not sure this is a true minimum age (as might be in the case in 14C in post-glacial lake sediments). I think the likelihood of inheritance in bedrock should suggest that even the youngest bedrock ages are a “maximum”.

Technical Comments

Site Averages – I was unable to find any description of the averaging statistics the authors are employing for each of the sites. What is the form of averaging (error weighted or straight mean)? What is the joint uncertainty in the average ages (error-weighted sigma or standard error)?

Line 229-230 – This sentence is confusing. Consider rewording.

Line 319 – what is meant by the phrase “under the same token”?

Line 324 – “. . .the authors have chosen to use uncalibrated 14C ages from land. . .” Which authors are being cited here? The previous sentence cites two papers. Or are “the authors” referring to the writers of this manuscript?

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