

Interactive comment on “Multi-decadal to-century NAO-like marine climate oscillations across the Denmark Strait ($\sim 66^\circ$ N) over the last 2000 cal yr BP” by J. T. Andrews and A. E. Jennings

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Response to reviewers CP-2013-90

In general we approve of the ‘Climate of the Past’ model where the reviewers’ comments are made available to interested readers, as are the responses. This is especially important to us, as both Andrews and Jennings have seen several instances where their detailed comments were ignored in the final published paper, but this is not at all evident in the “traditional” journals where the reader has no access to reviewers’

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concerns. However, we do suggest that reviewers should not be “anonymous.” Another general comment we wish to make is that given any body of data, there is no single “best” way to organize and present the data thus authors and reviewers commonly will disagree.

We truly appreciate the comments of Reviewers #1 and #2 and we will make changes in the final paper to address some of the concerns, which we more fully discuss below.

Reviewer 1:

Reviewer #1 is concerned with the chronological control on several of the cores. This is an area of concern that we have addressed for several years (e.g. Andrews et al., 1999). We note that the term “high resolution” is not used in the title although we certainly use the terms “multi-decadal to (multi)-century” (now changed to —millennial). We would certainly agree that some of the cores (e.g. K-7 and K-8) have minimal chronological control but since they are in an area of high rates of sediment accumulation the changes in grain-size and mineralogy reflect clearly multi-decadal to (multi)-century changes. However, what limited chronological control severely restricts is the ability to correlate a particular event in such cores to those in adjacent and chronologically well/better-controlled cores, such as in this case, MD99-2322 and HU93030-19B or even JM96-1210—however, we did not attempt such correlations. In general we would have to agree with Telford et al (2003) that: All age-depth models are wrong: but how badly?

We make three observations about our records from the mouths of Nansen and Kangerlussuaq fjords, 1) they have little calcite hence we make no attempt to pose the correlations on this proxy that are a central part of the paper, 2) the lack of calcite in the sediment source areas confirms that the variations in calcite in Kangerlussuaq Trough are associated with variations in marine biological productivity, and 3) the importance of these sites is that their sediment mineralogies reflect the fundamental source contrast in composition (early Tertiary volcanics versus Precambrian basement) that is used to

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interpret one facet of the record in MD99-2322. Obviously it is important to obtain as many dates per core as is reasonable but this is restricted by issues of 1) availability of sufficient material for an AMS 14C date, and 2) monies available. In East Greenland fjords a combination of high rates of sediment accumulation and corrosive Polar Water make the task of obtaining a sufficient mass of foraminifera (~4 mg) difficult and very time consuming. The reviewer focused on two cores where this complaint could be made but as shown in Table 1 there are several cores which we describe that have > 3 dates and as many as 6. The reviewer questions our use of 14C dates in this paper versus those in a paper (Alonso-Garcia et al in press). As of Sept. 29th, 2013 this paper is not yet in proof so is unavailable to readers. However, the reason why those dates were viewed with suspicion is detailed in that paper. These 20-cm long gravity cores were taken in 1990 and stored wet in a cold room. Obtaining sufficient quality material for dating was difficult and the results showed age reversals whereas the Cs and Pb data were consistent. We also note that these cores only extend back to ca AD 1850. The Alonso-Garcia et al (in press) paper also documents regional (Denmark Strait area) SARs based on Cs and Pb dating methods. The underlying issue here is the possible changes in the sediment accumulation rates (SAR) over the last 2000 cal yr. We have considerable experience (decades) on dating marine cores and can state emphatically that it is rare to see significant changes in the SAR from a monotonic value, in late to mid-Holocene records. The exception is in fjords where turbidities are “instantaneous” events, but such events are not seen in MD99-2322 or cores along the Iceland margin. We certainly agree that chronological certainty is always an issue and the changes we have made in the text will address the issue. Few research projects can afford the detailed 14C analysis and wiggle matching published in Sejrup et al (2011), even though this would be the ideal to aim for. We would also point to our Conclusions where we state: “We conclude by noting that there is an “uncertainty principle” to the chronologies of high-resolution Holocene marine records and the delimitation of episodes such as the MWP and LIA (Fig. 8)” and then proceed to list some of the problems. In the end you have to work with what is available based on resources,

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including time and money and understand that each depth/age model is always a work in progress. As noted in Andrews et al (1999) the \pm errors on interpolated ages are \geq the error estimates on the bounding dates (Table 1).

The reviewer makes an interesting observation on the differences between our data and the Kaufman reconstruction (Fig. 10A), especially over the last 1000 yr, and one which we had not noted. This is especially evident between \sim AD1400-1600 but we have no specific explanation to advance.

The reviewer suggests that we should compare in more detail the calcite records from both sides of Denmark Strait. Calcite and quartz data at \sim 30-yr resolution was obtained by Moros (in Moros et al., 2006) on MD99-2269 and we will compare MD99-2322 and MD99-2269 at a common integrated 30-yr sampling interval for coherence in their records. This will result in a new Fig. 11. In addition, this has brought home to us the rather obvious conclusion that the multi-decadal to –century oscillations are superimposed on dominant longer trends, thus it appears appropriate to change the title of the paper to “Multi-decadal to –millennial. . .”

In our revised paper we will address some of these concerns.

Reviewer #1 also suggested several changes in the figures, which we certainly considered. Merging of Figures 1 and 2 is certainly possible but when this was attempted the resulting figure was too complex with too much information. Figure 2 does include the core sites (small dots). Note sure what is meant re Fig 4 by “weight” – probably saying that we should change the caption to say Figure 4: Total carbonate weight % (will do). Figure 5: The caption states that A is from JM96-1210 and “Lower panel” is from BS1191-K14. Not sure what is the issue here.

At the suggestion of the reviewer we will delimit some of the key climate episodes (LIA, MWP etc). This was included on Fig. 8 and will do so as well on Figure 11.

Andrews, J.T., Barber, D.C., Jennings, A.E., 1999. Errors in generating time-series

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and dating events at late Quaternary (radiocarbon) time-scales: Examples from Baffin Bay, Labrador Sea, and East Greenland, In: P.U. Clark, R.S. Webb, a., Keigwin, L.D. (Eds.), Mechanisms of Global Climate Change at Millennial Time Scales. American Geophysical Union, Washington, D.C.

Andrews, J.T., Hardardottir, J., Stoner, J.S., Mann, M.E., Kristjansdottir, G.B., Koc, N., 2003. Decadal to millennial-scale periodicities in North Iceland shelf sediments over the last 12,000 cal yrs: long-term North Atlantic oceanographic variability and Solar forcing. Earth and Planetary Science Letters 210, 453-465.

Sejrup, H.P., Hafliðason, H., Andrews, J.T., 2011. A Holocene North Atlantic SST record and regional climate variability. Quaternary Science Reviews 30, 3181-3195.

Telford, R.J., Heegaard, E., Birks, H.J.B., 2003. All age-depth models are wrong: but how badly? Quaternary science Reviews 23, 1-5.

Reviewer #2

The reviewer suggests some reconfiguration of the paper in terms of material on climate etc. This will be done.

Page 3874, line 29: true—an error and will alter.

Have added some bedrock information to the text and to Figure 1—it now outlines the three major units: Precambrian basement rocks, Caledonides north of Scoresby Sund, and Tertiary volcanics. However, we do not feel that a totally new figure of the bedrock geology for E/NE Greenland is required as our studies indicate that the imprint of the Caledonian outcrops is extremely limited south of Scoresby Sund (Andrews et al., 2010, in press).

Page 3883, line 24. A valid question but. . .the observations of Dowdeswell et al (1992) on iceberg freeboards in the area and the seafloor observations of Syvitski et al. (2001) within Kangerlussuaq Trough indicate that large, deep-draughted icebergs do exit the fjord—sill is ca 450 m wd. On one Landsat image we see a vast plume of icebergs

spread out from Kang Fj and it is worth noting that intense down-fjord winds are a feature of the region (have a local Innuite name).

P 3884, line 3-4: Do't fully understand as the record from 19B extends to 1993—this may not be true for the last 20 yr.

Yes, calcite is shown twice on Fig. 8 but in different contexts—we think the figure would be too “busy” if we tried to go with 3 lines.

We use “Cite while you write” via EndNotes, hence there should not be any missing references. We have gone through the list of references and, at the moment, found no missing ones. However, we will undertake another check on the final paper.

Dowdeswell, J.A., Whittington, R.J., Hodgkins, R., 1992. The sizes, frequencies, and freeboards of East Greenland icebergs observed using ship radar and sextant. *Journal Geophysical Research* 97, 3515-3528.

Syvitski, J.P.M., Stein, A., Andrews, J.T., Milliman, J.D., 2001. Icebergs and seafloor of the East Greenland (Kangerlussuaq) continental margin. *Arctic, Antarctic and Alpine Research* 33, 52-61.

Figures 1, 9.11 and and 12???? have some changes. In addition we would note that we have added some references and deleted a few others and have checked for omissions. About $\frac{1}{2}$ of the Abstract will be rephrased.

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