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Climate of the Past Discussions

Interactive comment on "The role of the northward-directed (sub)surface limb of the Atlantic Meridional Overturning Circulation during the 8.2 ka Event" *by* A. D. Tegzes et al.

Anonymous Referee #2

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'The role of the northward-directed (sub)surface limb of the Atlantic Meridional Overturning Circulation during the 8.2 ka Event' by Tegzes, Jansen and Telford.

Summary: It is still fairly poorly understood how the discharge of freshwater into the subpolar North Atlantic during the 8.2 ka event affected the transport of warm waters to the Nordic Seas (one of the branches of the surface limb of the AMOC). This study tackles this question by using a sediment core from the Voring Plateau which is located in the pathway of the continuation of the North Atlantic Current (the Norwegian Atlantic Current- NwAC). Grain size measurements of the terrigenous fraction of the sediment are used to reconstruct changes in the transport of these Atlantic inflow waters to the Nordic Seas. The results are discussed and compared to previously pub-

lished surface records from the same site. However, a large part of the discussion in the paper involves reviewing already published data and discussing the oceanic processes happening during the 8.2kyr event. The paper is well-written but there are a few weaknesses that need to be addressed before publication.

General Comments: In Page 668 Line 15 the authors state that the current has not been in direct contact with the sediment. How has it influenced the sedimentation processes by sorting the sediment at the core site? This statement forms the basis of the paper. It is essential that the mechanism by which the sediment at the site is sorted by the NAwC strength is explained in-detail. Information on the present oceanographic setting at the site should also be included at this point in order to convince the reader that the grain size measurements from this site are indeed indicative of changes in the strength of the NAwC. The authors explain (Page 669, Line 11) that they have used the true mean grain size, which is calculated from the average of the differential number distribution of grains within a sample as opposed to the volume (sortable silt). Naming this the 'true' mean grain size is misleading since the coulter counter measures the volume and not the size and this parameter is calculated by using the number of grains as opposed to the volume. It may also be useful to present the formulas used to calculate the SS and 'true mean grain size' so it is clearer to the reader what these two parameters are. The discussion that the authors present regarding the robustness of the grain size parameters is interesting. However, why the 'true mean grain size' is better than the volume is not fully justified. The references used to back-up this argument in line 15 Page 269 are not accessible. The discussion largely includes explanation of the discrepancies and similarities between previous published records and explores the lake-outburst theory, the IRD records and the comparison between the surface records from Gardar Drift and the ice-core records. However, the interpretation and discussion from the grain size data presented in this study is very limited and fairly inconclusive. I wonder if perhaps the discussion can be extended to try and incorporate the new findings and explain the grain size record in the context of changes in the AMOC instead of the exhaustive review of previous literature on this topic. For instance: How does this data compare to the hydrographic changes of the Atlantic inflow from subpolar North Atlantic records or modelling studies [e.g. Thornalley et al., 2009; Bamberg et al., 2010; Born and Levermann, 2010]. Or whether the changes observed in the Voring Plateau are concomitant with changes in the overflow waters (as increased/decreased in the overflows would lead to increased/decreased Atlantic inflow reaching the Nordic Seas – e.g. comparison with [Ellison et al., 2006; Kleiven et al., 2008; Kissel et al., 2013]. The apparent difference in the relative timing between the SS and δ18O from N. pachyderma (s) (Nps) (Page 671 line 6) could be due to differential size mixing via bioturbation processes of each of the signal carriers (SS in the <63μm and δ18O Nps in the >63μm fraction) this would lead to decoupling of these two paleoceanographic records obtained from the same core and an offset of 1cm wouldn't need such a large mixing layer [Bard, 2001; Weedon, 2003].

Section 5 is rather confusing. It firstly explains that the foraminifera from which the δ18O from Nps was obtained at this time-interval [Risebrobakken et al., 2003, 2011] could have been reworked. On the basis that the change in the SS and the δ18O from Nps does not happen at the same time (1cm off) the authors conclude that these signals must have been influenced by different processes and are therefore a climate signal. However, that 1cm difference between the SS drop and the δ18O increase could be accounted for by bioturbation as mentioned earlier so this reworked material may have also affected the SS. This section needs rewriting as it is not clear and it makes the reader doubt if indeed the core is intact or contains reworked material.

Page 675 Line 4, there is a series of hypothetical feedback mechanisms explained in this paragraph, but there is a lack of references backing these up. Please add these.

Specific comments: Page 668 Line 28. As a side note, 5-10% concentration is a large concentration to be running on the coulter counter. Ideally it should be below 5% to avoid coincidence of particles. Page 670 line 1. Depending on how confident the authors are about the mechanisms by which the sediment sorting occurs at the site, it may be, that this current has not always affected the sediment deposition at this core

location in the same way, perhaps due to E-W or vertical migrations of the current when it was weaker/stronger.

Page 670 line 10. At this point the authors mention that they will use the traditional SS proxy. After having argued in the methodology section that the 'true mean grain size' is better, using SS here is a bit confusing.

Page 671 line 15. The %Nps coincides with the heavier δ18O event. Sentence starting in line 16 is very vague, and also the follow-up sentence.

Page 674. This difference between coarse and fine fraction relative timing could be accounted for by bioturbation.

Page 677 line 4. Check salinity subpolar gyre reconstructions from [Thornalley et al., 2009]. Also check [Bamberg et al., 2010].

Figures: Fig1. Figure1A and 1B could be merged into one figure Fig 2. It would help if the raw data was presented here as opposed to the normalised records. The raw SS values are also useful as the larger the grain sizes and their larger magnitude of variability the measurements will be less prone to error. Fig.3 and 4 are very complex and small. The colour scheme and the reduced size of the graphs makes it difficult to read them. Would it be possible to enlarge these figures and make the plots in black and white? Are all of the plots needed?

References: Bamberg, A., Y. Rosenthal, A. Paul, D. Heslop, S. Mulitza, C. Rühlemann, and M. Schulz (2010), Reduced North Atlantic Central Water formation in response to early Holocene ice-sheet melting, Geophys. Res. Lett., 37(17), L17705, doi:10.1029/2010GL043878. Bard, E. (2001), Paleoceanographic implications of the difference in deep-sea sediment mixing between large and fine particles, Paleoceanography, 16(3), 235–239, doi:10.1029/2000PA000537. Born, A., and A. Levermann (2010), The 8.2 ka event: Abrupt transition of the subpolar gyre toward a modern North Atlantic circulation, Geochem. Geophys. Geosystems, 11(6), Q06011, doi:10.1029/2009GC003024. Ellison, C. R. W., M. R. Chapman, and I. R. Hall (2006), Surface and Deep Ocean Interactions During the Cold Climate Event 8200 Years Ago, Science, 312(5782), 1929–1932, doi:10.1126/science.1127213. Kissel, C., A. Van Toer, C. Laj, E. Cortijo, and E. Michel (2013), Variations in the strength of the North Atlantic bottom water during Holocene, Earth Planet. Sci. Lett., 369–370(0), 248–259, doi:10.1016/j.epsl.2013.03.042. Kleiven, H. F., C. Kissel, C. Laj, U. S. Ninnemann, T. O. Richter, and E. Cortijo (2008), Reduced North Atlantic Deep Water Coeval with the Glacial Lake Agassiz Freshwater Outburst, Science, 319(5859), 60–64, doi:10.1126/science.1148924. Risebrobakken, B., E. Jansen, C. Andersson, E. Mjelde, and K. Hevrøy (2003), A high-resolution study of Holocene paleoclimatic and paleoceanographic changes in the Nordic Seas, Paleoceanography, 18(1), 17–1. Risebrobakken, B., T. Dokken, L. H. Smedsrud, C. Andersson, E. Jansen, M. Moros, and E. V. Ivanova (2011), Early Holocene temperature variability in the Nordic Seas: The role of oceanic heat advection versus changes in orbital forcing, Paleoceanography, 26(4), PA4206, doi:10.1029/2011PA002117. Thornalley, D. J. R., H. Elderfield, and I. N. McCave (2009), Holocene oscillations in temperature and salinity of the surface subpolar North Atlantic, Nature, 457(7230), 711–714, doi:10.1038/nature07717. Weedon, G. (2003), Time-Series Analysis and Cyclostratigraphy. Examining stratigraphic records of environmental cycles., Cambridge University Press, Cambridge.

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