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Interactive comment on “Late Weichselian and Holocene paleoceanography of Storfjordrenna, southern Svalbard” by M. ŁÄĘcka et al.

Anonymous Referee #2

Received and published: 22 September 2014

This paper presents novel data of Late Weichselian and Holocene paleoceanography in Storfjordrenna, Svalbard that are within the scope of CP. The study is based on a marine sediment core and analyses include lithology, magnetic susceptibility, XRF, grain size distribution, IRD, benthic foraminiferal census counts, planktic foraminiferal fluxes, and stable isotope analysis (d18O, d13C) measured on the infaunal benthic foraminifera *Elphidium excavatum* f. *clavata*. The study also presents a new radiocarbon date elucidating the retreat of the Barents Sea Ice Sheet (BSIS). The study is very timely; however, the paper is hampered by several factors. The objectives of the study are not well presented. The introduction is unclear and includes too many details that are not relevant for the study. The authors do give proper credit to related work and clearly indicate their own new contribution, however at some places proper references are not made (please refer to additional comments). The title and abstract are concise.

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The overall presentation is well structured and clear. The language is fluent, nonetheless it is clear that neither of the authors are native English speakers and expressions as “evanescent delivery of IRD” or the use of “hydrology” where “oceanography” is more appropriate needs to be corrected. Data are relatively clearly presented; some figures are hampered by irrelevant data combination or not enough data are displayed or documented (please refer to additional comments). The last figure (Fig. 9) also appear not to be relevant and should be removed. The quality of the references is appropriate, but it appears that some relevant key literature has not been included in the paper (please refer to additional comments). This greatly affects the discussion, which is also hampered by some parts that need more discussion including necessary key references.

Additional comments Abstract “...the beginning of late Holocene...” – when? Please indicate ca. calendar years BP.

Introduction Page 3055, line 10: Which fjords? Be more specific.

Page 3055, lines 18 – 29: Too detailed – include only main point.

Page 3056, lines 1 – 11: The development of the knowledge and understanding of water masses in Storfjord seems to be beyond the scope of the current paper. I suggest removing all. Some details may be relevant in chapter 2 on study area.

Page 3056, lines 14 – 16. What time? Be more specific and add more on this. The information is very relevant for the scope of the paper. Refer to Rasmussen et al. (2007) and the recent paper by Rasmussen et al. (2014) (Quaternary Science Reviews 92, 280-291. Online November 2013)

Page 3056, lines 17 – 19. Introduction lacks a coherent part on previous paleo-records from the region and Storfjordrenna. These sentences should be combined with the previous making a proper introduction to previous paleo-records from the region and Storfjordrenna. Introduction to the deglaciation of the Barents Sea Ice Sheet is also

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lacking.

Page 3056, lines 20 – 24. Unclear where the authors wish to take this?

Page 3056, lines 25 – 29. Clear presentation of study, but the introduction should contain information leading up to this and make objectives more clear.

Page 3057, lines 10 – 13. This belongs to "Introduction", where more details on retreat are necessary making it clear why a new age on the retreat is relevant.

Page 3057, lines 16. "(Table 1 after Skogseth et al., 2005)" should be corrected to "(Skogseth et al., 2005; Table 1)".

Page 3058, lines 9 – 11. Reduce the numbers of references.

Page 3058, lines 24 – 25. Simply refer to figure 2 without the details.

Page 3059, line 29. This reference does not deal with stable isotope measurements of *E. excavatum* f. *clavata* nor stable isotope measurements as a method. Please find relevant references on this and/or discuss accordingly.

Page 3060, lines 9 – 11. "Bivalve..." this belongs - with thanks - in Acknowledgement

Page 3060, line 16. Why not Marine13? This paper was submitted July 15 2014.

Page 3062, lines 2 – 4 a. This is the first place where the boundaries of the lithological units are presented, use and list both core depth in cm and ages in cal yr BP.

Page 3062, lines 2 – 4 b. In figure 4 of the lithology the boundaries between the units are sharp. Hence, the use of "~"/"ca." is not quite right, and all "~" should be deleted throughout this chapter.

Page 3062, line 9. Delete "Munsell code".

Page 3062, lines 13 – 14. >63 um AND between 7-10 um? This must be a mistake; please correct.

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Page 3062, lines 24 – 25. Is there a color change between L3 and L4? If yes, please describe this.

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Page 3062, lines 26 – 27. Again >63 AND up to 15?

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Page 3063, line 6. Make it clear this is the relative abundance.

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Page 3063, lines 7 – 8. "...with 25% of agglutinated foraminiferal fauna..." – what do the authors mean here? Have the agglutinated foraminifera been included in the calculations of relative abundance or does the calcareous species constitute 100% in the calculations?

Page 3063, lines 8 – 9. What is low? Please state the value of this sample.

Page 3064, lines 1 – 28. Throughout the description, mention numbers in addition to "high" and "lower".

Page 3064, line 1. Which species is the most frequent?

Page 3064, line 5. Low biodiversity? Please state the value of this sample and what it is compared to.

Page 3064, lines 22 – 25. Which species are the most frequent?

Page 3065, lines 18 – 19. Please make it clear that this is a minimum estimate.

Page 3065, lines 19-25. It is emphasized in the introduction that a new age on the deglaciation of BSIS is presented. This new date should be discussed in light of the latest results from the region, please refer to e.g. Andreassen et al (2014) and Rüther et al (2012).

REFS: Andreassen, K., Winsborrow, M.C.M., Bjarnadóttir, L.R., Rüther, D.C., 2014. Ice stream retreat dynamics inferred from an assemblage of landforms in the northern Barents Sea. Quaternary Science Reviews 92, 246-257 (online November 2013). Rüther, D.C., Bjarnadóttir, L.R., Junntila, J., Husum, K., Rasmussen, T.L., Lucchi, R.G.,

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Andreassen, K., 2012. Pattern and timing of the northwestern Barents Sea Ice Sheet deglaciation and indications of episodic Holocene deposition. *Boreas* 41, 494–512

Page 3066, lines 7 – 9. A reference on this?

Page 3066, line 11. Indicate the lithological units on the figure with foraminiferal data. It is not possible to assess this statement/correlation easily.

Page 3066, line 12. *A. gallowayi* is not epibenthic, but infaunal? In the Barents Sea, it is often found in areas with coarse sediments and stronger bottom currents together with *C. lobatulus*. NB I cannot find any mentioning on *A. gallowayi* in the cited reference: Hald & Steinsund 1996.

Page 3066, lines 17–18. This needs to be elaborated.

Page 3066, lines 22 – 24. A reference on propagules is needed.

Page 3066, lines 27. What kind of ice? Please discuss and make it clearer.

Page 3067, line 1. No, *Elphidium excavatum* f. *clavata* may also be the most frequent species in other environments than glacier proximal environments, e.g. Saher et al, 2009. In order to make this interpretation it is necessary to refer to studies of the position and distribution of the BSIS at this point.

Page 3067, lines 5 – 6. Which areas are these records coming from? There are additional records that should be included in the comparison.

Page 3067, lines 13 – 16. It must be emphasized in the text what the temporal resolution is, and that there are not that many data points in this interval...

Page 3067, lines 16 – 17. A more specific describing is needed.

Page 3067, lines 18 – 19. It is necessary to refer to a study of this mechanism.

Page 3067, lines 20 – 27. This need to be presented and discussed in much more detail, also refer to Bakke et al 2009 (Nature Geoscience, DOI: 10.1038/NGEO439)

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Page 3068, lines 1 – 3. It is not clear what the authors mean with this? Heavier d18O values = warmer water? Explain in more detail and be specific.

Page 3068, lines 8 – 9. It is necessary to include other type of data/references on the position of BSIS. It cannot be included solely on the foraminiferal content. This interpretation has to be supported by other findings.

Page 3068, lines 14 – 19 a. The values of the current study are lighter from xxxxx cal yr BP and not just from 11500 cal yr BP. It must be addressed.

Page 3068, lines 14 – 19 b. Are these values robust? It should be discussed if there are any dissolution effects on the isotope record.

Page 3068, lines 14 – 19 c. Any references confirming Arctic Water are isotopically lighter than AW?

Page 3069, line 3. Correct the spelling of “mollusk”.

Page 3069, lines 5 – 7. This ratio has not been described or addressed before? That is necessary or this should be left out altogether.

Page 3069, line 22. Erbs-Hansen et al (2013) is about a paleo-record. The current ecological interpretations must be based on modern analogues/ studies of recent fauna.

Page 3069, lines 19 – 20. Khusid and Polayk (1988) is a study from Arctic Ocean? Argue why it is relevant for this study area. It is recommended to use Saher et al 2009 which is a study of modern foraminifera in the current study area. REF: Saher, M., Kristensen, D.K., Hald, M., Korsun, S., Jorgensen, L.L., 2009. Benthic foraminifera assemblages in the Central Barents Sea: an evaluation of the effect of combining live and total fauna studies in tracking environmental change. Norwegian Journal of Geology 89, 149-161.

Page 3069, line 29 - page 3070, line 3. It is not quite right to assume. *M. barleanus* cover a wide temperature range. Please refer to for example Hald & Steinsund 1996

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(Berichte zur Polarforschung 212, ISSN 01765027) which the authors have used previously in this paper.

Page 3070, lines 4 – 5. Explain how/why?

Page 3070, lines 5 – 8. This need to be seen in the light of the unusual light values prior to this time (cf figure 8). What happens here? Could these values influenced by dissolution?

Page 3070, lines 9 – 11. This needs to be discussed in much more detail before this may be suggested. Other paleoceanographic records from the Barents Sea and Svalbard region must be taken into account as well, e.g. Risebrobakken et al, 2010. *The Holocene*, 20, 609-621.

Page 3070, lines 18 – 21. Before comparing to terrestrial records compare to paleoceanographic records from the region including new work by Groot et al 2014; Berben et al, 2014, then compare to other records as Forwick et al (2010).

REFS: Berben, S.M.P., Husum, K., Cabedo-Sanz, P., Belt, S.T., 2014. Holocene sub-centennial evolution of Atlantic water inflow and sea ice distribution in the western Barents Sea. *Clim. Past* 10, 181-198. Groot, D.E., Aagaard-Sørensen, S., Husum, K., 2014. Reconstruction of Atlantic water variability during the Holocene in the western Barents Sea. *Clim. Past* 10, 51-62.

Page 3070, lines 21 – 25. Please summarize and present this with less detail.

Page 3070, lines 25 – 29 a. Explain why *M. barleanus* indicate an increased influence of AW + cite a references on its modern ecological preferences.

Page 3070, lines 25 – 29 b. Explain/discuss the apparent contradicting signals of more AW and more IRD

Page 3071, lines 14 – 15. This must be explained and argued in more detail. Please refer to later comments on figure 5.

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Page 3071, lines 16 – 18. This is difficult to understand? On figure 6 it very much looks like the values become slightly heavier (higher values) for the period 3600-1200 cal yr BP indicating minor cooling and/or more salty water masses?

Page 3072, lines 1 – 3. Shortly state what happens with the flux shown in figure 4 and refer to figure 4 alone instead of referring not quite rightly to figure.

Page 3072, lines 3 – 4. References on the modern distribution and ecological controls of these species must be stated. NB *C. reniforme* is not opportunistic. It is also necessary to discuss the interpretations stepwise. *N. labradorica* and *Islandiella* spp. are abundant in areas with a high biological productivity in the upper surface waters. High biological productivity occur near oceanic fronts and/or near ice margins, hence the current foraminiferal fauna indicate that the core site is near an oceanic front or near an ice margin. In the Barents Sea *Islandiella* spp has been found near marginal ice-zones, hence here it is interpreted that the core site is near a marginal ice-zone. In figure 9 *Islandiella* spp. is plotted together with IRD, this is not discussed further in the paper as it should. It appears that they only correlate in Late Holocene, hence *Islandiella* spp linked to sea ice using this correlation.

Page 3072, lines 6 – 7. A reference on this?

Page 3072, lines 13 – 17. The correct reference is Rasmussen et al. (2014). Rasmussen et al (2014) find that "During the last 2000 years conditions have been increasingly unstable although with slightly increasing subsurface temperatures" which is also shown by recent studies by Groot et al (2014) and Berben et al (2014), both Climate of the Past, vol 10. The latter reference also include reconstructions of sea ice using sea ice biomarkers.

Figures Figure 5 a: Indicate the unit of the fluxes; I assume it is specimens/g dry sediment/year?

Figure 5 b: Some of the ecological tolerances is over simplified and/or not quite right

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and must be corrected: *C. reniforme* is not opportunistic. The term “high sea productivity”? – be more specific

N. labradorica and *M. barleanus* are correctly connected to high biological productivity. This can occur in several settings. This also apply to *Islandiella* spp and *Bucella* spp, so it is not possible to divide them into these two groups of “ocean front” and “ice margin”. They should all be labelled as “high biological productivity”. The interpretation of ocean front vs ice margin must be done using other data and proxies from current study or existing knowledge.

Figure 6: Data are displayed poorly mixing parameters that does not belong together. Move species richness, diversity and planktonic flux to figure 5. Keep these parameters together with the relevant benthic foraminiferal data and plot stable isotopes separately. NB add the flux of *T. quinqueloba* to the planktonic data. The number may be low, but it may elucidate the influence of TAW.

Figure 7: show data points of the IRD flux and $d_{18}\text{O}$ making the temporal resolution of the current study clear.

Figure 8: Plot all $d_{18}\text{O}$ data from the current study, i.e. begin y-axis at 14.500 cal yr as figures 5-6.

Discuss the lighter values in more details in the paper. Consider to make a plot of $d_{13}\text{C}$ vs $d_{18}\text{O}$ values from the current study evaluating the water masses (cf. Rasmussen, T.L., Thomsen, E., 2009. Stable isotope signals from brines in the Barents Sea: Implications for brine formation during the last glaciation. *Geology* 37, 903-906).

Figure 9: This comparison of *Islandiella* spp. and IRD are not properly discussed in the paper. As mentioned previously it appears that *Islandiella* spp cannot be linked to sea ice using this correlation.

Interactive comment on *Clim. Past Discuss.*, 10, 3053, 2014.

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