Clim. Past Discuss., 8, C1815–C1818, 2012. www.clim-past-discuss.net/8/C1815/2012/

Reply to the **Interactive comment on "An Ocean – ice coupled response during the last glacial: zooming on the marine isotopic stage 3 south of the Faeroe Shetland Gateway" by J. Zumaque et al., by Anonymous Referee #2,**
Received and published: 8 October 2012

The authors present new multi-proxy MIS3 data from a high-sedimentation MD-core taken in 1999 south of the Faeroe-Shetland Gateway. In their ms, they focus on dinocyst assemblages for the time-interval 26 to 42 kyrs BP and add paleomagnetic, XRF-corescanner, planktonic foram (NPS) abundance and d18O, and IRD (lithic grains) data to document the sensitive response of this oceanic area to the abrupt MIS3 climate oscillations, particularly investigating the role of the Fennoscandian and British Ice Sheets dynamics on the local surface hydrology. The paper is generally well-written and structured with a suitable introduction to the topic citing all the relevant literature and with figures presented in a commendable way. However, **I am missing an introduction to the regional paleoceanographic works on MIS3**, which appears in the later part of the discussion. **Some chronostratigraphic issues as well as some critical proxy-related aspects, however, weaken the discussion of these new data especially with respect to the already published paleoenvironmental reconstructions from this region.** (…)

Reviewer#2 has underlined points of criticism that are quite similar to those of Reviewer#1, i.e. regarding the age model (+ sampling resolution) and the reliability of the proxies. As such, some issues have already been considered with our response to Reviewer#1 (see online document). They are referred here again for each reply to Rev#2..

(…) The stratigraphy of the core is basically a tuned age model to the NGRIP-GICC05 chronology. Up to 36 kyrs the authors use radiocarbon ages from Boulay (2000) (Master-thesis), four additional radiocarbon ages from ARTEMIS (2010) (ref. is missing; two dates were rejected) that are calibrated after Bard (1998). The radiocarbon dates are not reported properly (Lab-ID, reservoir correction etc) and the calibration method after Bard (1998) might be outdated and new calibration curves are available. (…)
A new Table 1 has been included in reply to Rev#1 comments. Regarding the new comment of Rev#2 we have added the Lab-Id and sample number also (see next page).

(…) Second, the older part of the age model is based on the correlation of magnetic susceptibility to NGRIP (Figure 3). If it holds true what the authors develop in chapter 4 (lines 11-24) it would have been good to show at least one correlation with a second MS record from the region. **It would also have been reasonable to show the magnetic paleointensity record, in order to substantiate the Mono-Lake and Laschamp excursions identified in the investigated core.** This at least would justify the extended description of the paleomagnetic methods beside of determining the magnetic susceptibility. It is also obvious, that the MS to NGRIP relationship is not anymore straightforward in the interval >2200 cm core depth. (…)

The paleointensity record of core MD99-2281, compared to the GLOPIS-75 stack record, is now shown on the revised Figure 4 (see Reply to Rev#1). The correlation below 2200 cm has not been done versus NGRIP, it will be done in a next step when data will be acquired on this section of the record.

(…) While some of the presented data sets are real "high-resolution" data (e.g., XRF, MS) the other data has a moderately good resolution (av. 200 years; in a sediment core with a definitively much higher potential) which not really justifies the "zooming in"-approach claimed at in the title of the manuscript and which introduces some ambiguity in the interpretation of the data as well. Especially the dinocyst-derived MAT data are exemplifying this, since some of the interpretation is based on 1-2 datapoints only. A more detailed study of a narrower time interval may have revealed some more interesting aspects. (…)
Same response than for Rev#1: "…our sampling strategy provides us with a mean age resolution of 160 years (from 55 to 374 years between two points at worst) over nearly 15 000 years. Very few studies exist in the

Depth (cm) in core MD99-2281	LAB_ID	AMS ^{14}C Age uncorrected (a BP)	Calendar Age corrected (CAL -a BP) Bard, 1998	Calendar Age corrected (CAL -a BP) CALIB 6.0	1 σ ranges: [start]	1 σ ranges: [end]	Coherency of the two Calibration method ([Δ])	Tie points (Age in CAL -a BP)	Dated Material / Age control points / References
40	GifA 100405	10 260 +/- 100	**11 165**	11 261	*11 137*	*11 384*	95	11 165	*G. bulloides*, S.Boulay (2000)
170	GifA 100406	12 970 +/- 110	**14 729**	14 657	*14 156*	*15 158*	72		*G. bulloides*, S.Boulay (2000)
270	GifA 100407	10 800 +/- 100	**12 081**	12 229	*12 070* *12 478*	*12 388* *12 517*	148	12 081	*G. bulloides*, S.Boulay (2000)
400	GifA 100408	11 060 +/- 110	**12 400**	12 431	*12 392* *12 520*	*12 470* *12 675*	31	12 400	*G. bulloides*, S.Boulay (2000)
510	GifA 100409	15 290 +/- 130	**17 529**	18 037	*17 931* *18 261*	*18 142* *18 490*	507	17 529	*N. pachyderma* s., S.Boulay (2000)
580	GifA 100410	15 760 +/- 170	**18 092**	18 219	*18 209* *18 494*	*18 228* *18817*	126	18 092	*N. pachyderma* s., S.Boulay (2000)
650	GifA 100411	16 040 +/- 140	**18 427**	18 777	*18 651*	*18 902*	349	18 427	*N. pachyderma* s., S.Boulay (2000)
780	GifA 100412	18 060 +/-160	**20 830**	20 630	*20 562* *20 903*	*20 697* *21 361*	200	20 830	*N. pachyderma* s., S.Boulay (2000)
1180	GifA 100414	23 340 +/- 240	**26 993**	27 144	*27 037* *24 522*	*27 251* *28 087*	151	26 993	*N. pachyderma* s., S.Boulay (2000)
1240								27 430	Correlation NGRIPGICC05 , GI3 termination, Wolff et al.,
1275								27 730	Correlation NGRIPGICC05, GI3 warming, Wolff et al., 2010
1280	SacA 19117	24 210 +/- 140	**27 992**	28 567	*28 326*	*28 807*	574	27 992	*N. pachyderma* s., ARTEMIS 2010
1300								28 550	Correlation NGRIPGICC05, GI4 termination, Wolff et al.,
1355								28 850	Correlation NGRIPGICC05, GI4 warming, Wolff et al., 2010
1430	SacA 19118	27 430 +/- 140	**31 652**	31 306	*31 211*	*31 400*	346	31 652	*N. pachyderma* s., ARTEMIS 2010
1440	SacA 19119	27 940 +/- 140	**32 226**	31 576	*31 411*	*31 740*	650		*N. pachyderma* s., ARTEMIS 2010
1475								31 950	Correlation NGRIPGICC05, GI5 termination, Wolff et al.,
1523								32 450	Correlation NGRIPGICC05, GI5 warming, Wolff et al., 2010
1548								33 290	Correlation NGRIPGICC05, GI6 termination, Wolff et al.,
1605								33 690	Correlation NGRIPGICC05, GI6 warming, Wolff et al., 2010
1650								34 730	Correlation NGRIPGICC05, GI7 termination, Wolff et al.,
1711								35 430	Correlation NGRIPGICC05, GI7 warming, Wolff et al., 2010
1755								36 570	Correlation NGRIPGICC05, GI8 termination, Wolff et al.,
1820	SacA 19121	34 610 +/- 290	**39 586**	39 105	*38 722*	*39 488*	481		*N. pachyderma* s., ARTEMIS 2010
1880								38 170	Correlation NGRIPGICC05, GI8 warming, Wolff et al., 2010
1930								39 810	Correlation NGRIPGICC05, GI9 termination, Wolff et al.,
1960								40 110	Correlation NGRIPGICC05, GI9 warming, Wolff et al., 2010
2030								40 710	Correlation NGRIPGICC05, GI10 termination, Wolff et al.,
2090								41 410	Correlation NGRIPGICC05, GI10 warming, Wolff et al.,
2110								42 290	Correlation NGRIPGICC05, GI11 termination, Wolff et al.,
2170								**43 290**	Correlation NGRIPGICC05, GI11 warming, Wolff et al.,

Table 1 (revised version)

literature giving a comparable resolution in the marine environment for this time window, i.e. MIS3. Our aim to conduct a multiproxy study, thus implying multiple analyses on each sample also limits the number of samples to study. We chose to cover the whole MIS3, which represents a zoom within the last glacial period (to justify our Title)."

(…) In chapter 6 the authors point out the good consistency between the different proxies used. This is true for most of them, but there are also some exceptions, which clearly require more attention. **One is, e.g. the K/Ti ratio. This record is not as clearly tight to the DO-patterns as the authors claim.**
There might be some interesting detail hidden here and the authors should look more differentiated to the XRF records. (…)

We actually discuss the XRF data in sections 5 and 6 and especially the ratios (Ti + Fe) / (Ca + Sr), K/Ti which correlate well with the LLG concentration in the sediment, thus preferentially signing terrigeneous input. We agree with Rev#2 that the K/Ti ratio appears more noisy but it however coherently marks stadials by high values and interstadials by lower values. One exception to this coherency is recorded at 39 ka but it was discussed in the text line 492, even if the K/Ti ratio was not mentioned (it is done now thanks to Rev#2). Some trends do occur within each DO (both within GIs and GSs), especially changes are typically graduals. We decided to include some new sentences in the manuscript regarding this observation. We have also included on the revised Figure 6 a smoothed version for the K/Ti ratio (3 points running average) to underline the good coherency with DO (see the following pages). We also have highlighted the 39 ka event.

(…) It is also not clear why **cold temperatures during interstadials as indicated by close to 100% NPS** are associated by warm summer (and in fact +4_ rel. to present) dinotemperatures? Present NPS% is at around 40%. (…)

The opposite is in fact observed in our results: maximum of NPs abundances marks the stadials…thus planktic foraminifera indicate cold temperatures when dinocyst indicate cold SST in winter but conversely warm SST in summer.

Our response here is the same than for Rev#1: "…Dinocysts and foraminifera represent two "planktonic" groups which have very different ecological requirements. The first group belongs to the organic phytoplankton whereas the second one is a calcareous zooplanktonic dweller. It is now well established that foraminifera could migrate within the water column, and that apart for symbiotic species, they could thrive below the thermocline/pycnocline (up to 700 m, e.g., Fairbanks et al., Science 1980). The polar species *Neogloboquadrina pachyderma* sinistral (NPS) form, which represents the dominant species in our planktonic foraminifera record (between 25 and 100%), is especially known to live at or below the pycnocline, notably at sites where low salinities characterize the surface layer (e.g. Simstich et al., Marin. Micropal. 2003; Jonkers et al., Paleoceanography 2010). Dinoflagellates preferentially occupy the topmost fifty meters (e.g. de Vernal & Marret, 2007). Many species are highly tolerant toward low salinity (from Wall et al., 1977 to de Vernal & Rochon, 2011). This specificity could explain why they develop in surface waters where adverse conditions are recorded for foraminifera (for some then probably living deeper in the water column …). Episodes characterized by "warm summers with no foraminiferal bloom" as pointed out by Reviewer 1 could thus be realistic considering the respective ecological tolerances of foraminifera and dinocysts and especially, if we envisage as suggested in our manuscript a strong stratification of the water column. …."

(…) Later in the discussion the authors mention water column stratification and fresh water advection in summer ("brackish water lens"). Do dinocyst MAT do not potentially provide (or are even biased by) also sea surface salinities to verify this assumption? (…)

Dinocyst actually provide reconstruction of sea-surface salinities, this set of data was not included initially in the paper but, regarding the comment of Rev#2 we decided to include it both on Figures 5 and 6 (see below) . The results obtained are convergent with our hypothesis, thus supporting the theory of low salinities during stadials in conjunction with high August SST. The result and discussion sections will be thus also modified consequently.

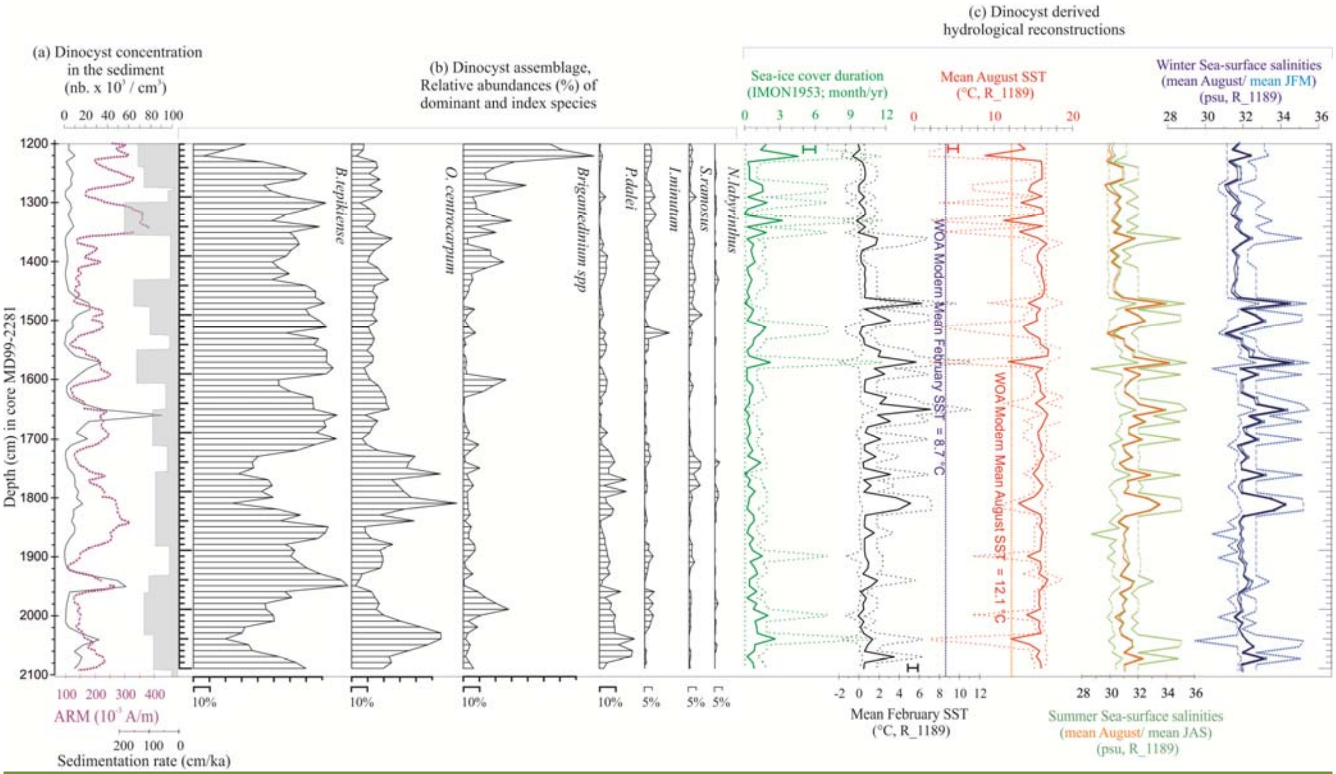

Figure 5 (revised version)

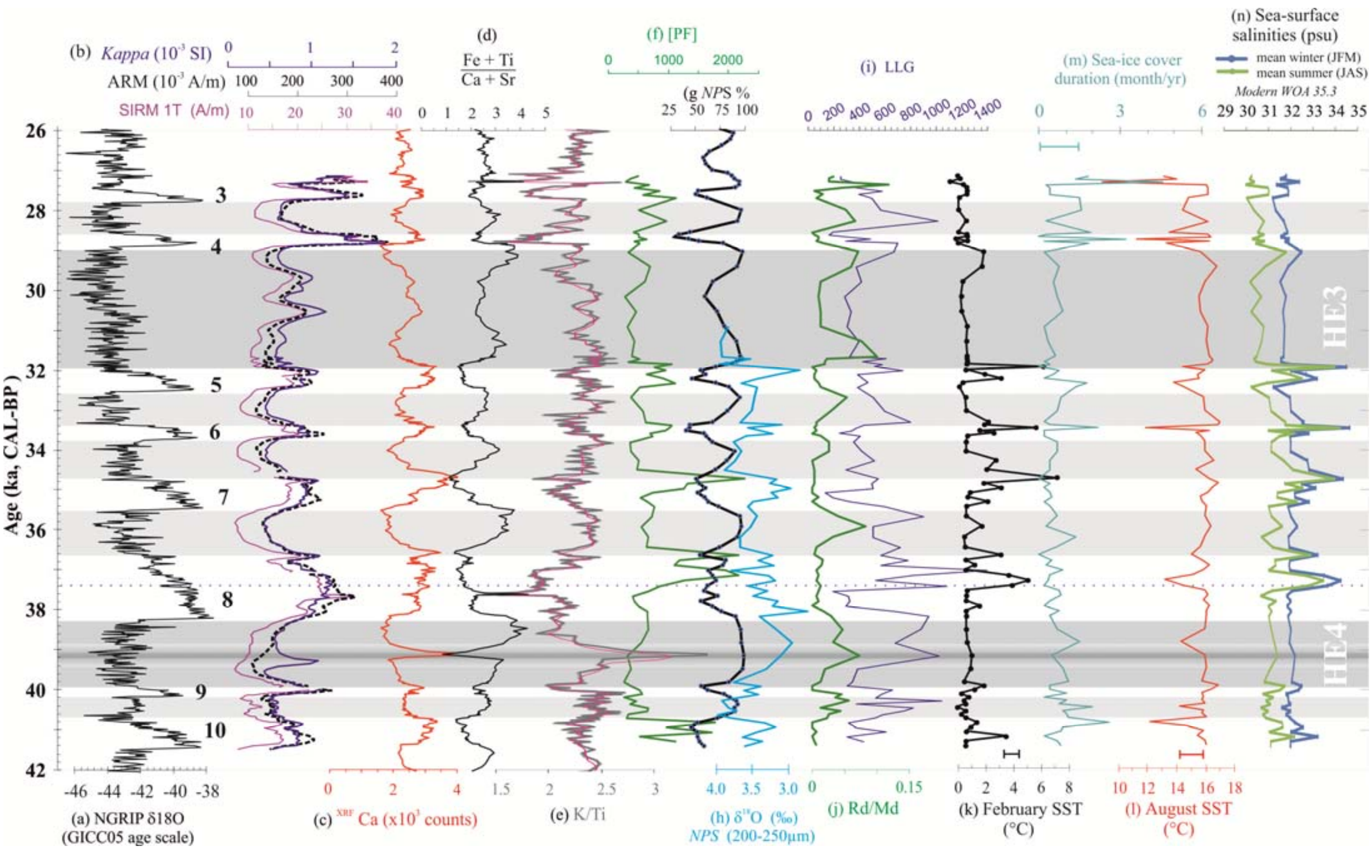

Figure 6 (revised version after Rev#2 comments)

(…) In Figure 5 the authors present the results on core MD99-2881. The colored dinocyst-related records are shown together with the (dashed) coldest/warmest analogues. What to learn from this, except graphically scaling up the record? Not having all the paleorecords from the region at the same time in mind (which are frequently discussed and referenced in the later part of the discussion) I would urge the authors to compile a graph that compares some relevant records mentioned in the text. (…)

As we understand, Rev#2 suggests to delete Figure 5 and to replace it by a synthetic Figure compiling records from the MIS3. This a good suggestion for the new Figure, that we will follow, but however, we are convinced that it is important to show also the "raw" record, without any age scaling modification. If the editor follows the advice of Rev# 2 we will thus delete Figure 4. It may however imply modifications on Figure 6 (adding the min. and max. values of the analogues), which will overcharge this already very rich Figure.

(…)

Minor remarks.

P3046, 14 "sediments by rich layers.." should be "sediments by layers rich.."
P3048, 1-4. At the end (see discussion) I don't have the impression that the manuscript provides dinocyst data AND additions, but the data are equally important.
P3051, l20. Which marker was used?
P3051, 20-24. Could reworked dinos indicate specific sources and how to differentiate between quaternary reworked and not reworked dinocysts?
P3053, 6. See comment above (P3048, 1-4) – this is not a good name for a chapter
P3053/54, 8-27/1-12. This detailed description is not really required since the interpretation is basically referring to the magnetic susceptibility and not to the full paleomagnetic record
P3053, 14-28. A complete description of this method provides also instrument setting during measurement etc.
P3053, 27-28. Not shown and therefore not relevant for present paper.
P3055, 1-6. It is not the scope of this paper to introduce planktonic foraminifera. First two sentences can be deleted.
P3055, 10. How many specimens were counted?
P3055, 20-26. How many grains were counted etc:
P3055, 22-23. Rewrite sentence P3056, 2. Replace collapses with dynamics
P3058, 10-25. This MAT sea-ice reconstruction indicates that sea ice was basically absent (regarding the statistical error) for most of the record and hard to interpret.
P3060, 18-19. Description but no interpretation?
P3061, GI8. What about the sharp peak in XRF data around 39 kyrs?
P3063, 2-4. Could a low salinity layer be traced/verified by one of the proxies?
P3063, 19. LLG are no "melt-water" products.
P3063, 20-27. LI-source of the Ca peak in H4 based on not-shown Sr-counts is much too hypothetical.
P3070, 8-10. The late and terminal warmings of GI's needs more discussion.
P3070, 19. Reconstructed ice-cover for <29 kyrs is max. 4-5 month/year. That would mean that the ice shelf was not OVER the core site

Table 1: Add dating details. Done
Fig. 1. Remove red dotted line (glacial ice sheet expansion) for the sake of clarity in the figure. Fig.7 shows the expansion as well.
Fig. 5. In (a) separate dinocyst concentration from ARM and sed. Rate. Precisely written, your age model is not simply "tuned on NGRIP-GICC05".
Fig.6. Check lettering of records (a,b,c: : :.) with figure caption. Its wrong. Corrected

Those points will all be corrected in the revised version of the paper.