Biogeosciences Discuss., 8, C1350–C1357, 2011
www.biogeosciences-discuss.net/8/C1350/2011/

Biogeosciences
Discussions

Interactive comment on "Sedimentary organic matter variations in the Chukchi Borderland over the last 155 kyr" *by* S. F. Rella and M. Uchida

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Received and published: 31 May 2011

We would like to thank the two anonymous referees for their helpful comments and suggestions for our manuscript.

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1) Age model 2) C/N ratio 3) Lateral transport from the Russian and Canadian margins 4) Technical corrections

1. Age model

Referees 1 and 2 raised concerns about our age model, which is based on a comparison of the LR04 d18O stack with CaCO3 and lithological constraints in MR08-04 PC1.

In order to improve our age model, we measured 14C at two neighbouring horizons at core depths of 122.6 and 125 cm and benthic d18O in PC1. The two 14C ages are consistent within error and suggest a calendar age of ∼46 ka, which is relatively well consistent with our age model used in the manuscript (Fig. S1). Variations in benthic d18O are a function of changes in global ice volume, bottom water salinity and bottom water temperature. The major change from the interglacial to the glacial stage (from MIS 5 to MIS 4) as documented in the LR04 benthic d18O stack, seems to be well resolved in our benthic d18O record (Fig. S1). The timing of this event is also consistent with our previous age model. We therefore suggest that our age model for the upper part of the core is supported by our additional analyses of 14C and d18O. In the lower part of the core, d18O is on average lighter than in the upper part of the core, giving some evidence that the lower part was mostly deposited during an interglacial period. Although point to point correlation of the LR04 stack to benthic d18O of PC1 is not straight forward below 350 cm in PC1 (apparently due to a stronger influence of bottom water temperature and/or salinity on benthic d18O), we suggest that the lightest d18O values at ca. 560 cm depth could be correlated to MIS 5e in view of the occurrence of a brownish layer in the same interval, which is indicative for peak interglacial conditions. Further support for this correlation comes from a comparison of the lithologies of core HLY0503-08JPC at the Mendeleev ridge (Yamamoto and Polyak, 2009; paper used in recommendation of referee 2) and PC1, because the pink-white layer occurring in HLY0503-08JPC at ca. 120 ka would correlate well to the pink-white layer in PC1 at the same time. By further correlating the laminations to glacial maxima of MIS 2 and MIS 6, the new age model would be relatively similar to our previous age model (in Fig. S1, previous correlation lines are shown in black and new correlation lines in red colour), although it is independent of the previously suggested correlation of CaCO3 to the LR04 stack. In the manuscript we would like to elaborate this observation and accordingly support our age model.

Referees 1 and 2 asked why we correlated the ending of MIS 6 to the younger laminated layer and not to the older laminated layer in the interval between 600 and 700 cm. We chose the younger laminations, because laminations can be expected during glacial stages in the Arctic rather than during interglacial stages. Would we have chosen the older lamination to mark the MIS 6 glacial maximum, the younger lamination would fall into MIS 5, which we would not consider probable. In the revised manuscript we will add this explanation.

Referees 1 and 2 also raised the question, if a comparison to NGRIP will be meaningful, given the uncertainty in the age model. We agree that changes in sedimentation rates could have occurred, and in absence of further constraints, we will point out in the revised manuscript that the uncertainty in age precludes strict correlation to NGRIP stadials or interstadials and that our interpretation needs to be seen with caution. Instead of suggesting a point to point correlation between TOC and NGRIP, we would like to more generally propose that millennial-scale peaks in TOC could be related to abrupt changes in high latitude northern hemispheric temperatures and encourage further study. If spectral analysis would prove meaningful to this regard, we also would like to include it, as suggested by referee 2.

2. C/N ratio

In Fig. S2, we plot TOC versus total nitrogen, as suggested by referees 1 and 2. The correlation is moderate, but still evident (R2=0.18). To improve the correlation, we propose to exclude a group of outliners (as indicated in Fig. S2) that correspond to the interval between 58 and 100 cm depth in PC1, and which may have been affected by inorganic nitrogen judging from the position of the samples in Fig. S2. Fig. S3 shows the new correlation (R2=0.24). According to the regression line, we would suggest to subtract 0.029% from total nitrogen to approximate total organic nitrogen. We propose to preliminarily include the thus calculated C/N data in the revised manuscript, although we leave it open to remove discussion on C/N, if recommended. In response to the concern of referee 1 to the anomalously high TOC values found in several samples (referring to page 2264, line 1), we reanalysed these samples and found no anomaly.

3. Lateral transport from the Russian and Canadian margins

Referee 2 suggested that our assignment of terrestrial organic carbon and calcite input from the Russian and Canadian margins, respectively, would be too strict. We agree with this opinion and will include in the revised manuscript the possibility that changes in carbonate diluted TOC. We would nevertheless suggest that increases in TOC at the Northwind Ridge may be well expected during cold periods due to glacial erosion, also mentioning the study of Yamamoto and Polyak (2009) who found increases in terrestrial OC during cold periods on the nearby Mendeleev Ridge that they associated with more efficient transport of organic matter from the land to the ocean. Yamamoto and Polyak(2009) also suggested that transport of terrestrial organic carbon during cold episodes would not be related to the coarse fraction. In view of these results and to provide further evidence for paths of lateral transport, we also measured the coarse (>63 micrometer) fraction of our samples, which show a good correlation to carbonate (Fig. S4). Because the carbonate-rich Canadian margin should be viewed as the primary source of detrital carbonate, while carbonate is rare or absent in the Russians margins and eastern Arctic Ocean (Bischof et al., 1996), we suggest that our more carbonate-rich and coarser samples would have mostly derived from the Canadian margins. In contrast, samples with low coarse fraction and lower carbonate could be either explained by advection of OC from carbonate-poor areas (such as the Russian margins), consistent with the results of Yamamoto and Polyak (2009), and/or by weakening of carbonate transport to the Northwind Ridge decreasing dilution of TOC by carbonate. As suggested by referee 2, we will plot modern organic carbon and calcite contents in Figure 1 of the manuscript based on Stein (2008), who summarized TOC contents from various studies, and Phillips and Grantz (2001). Unfortunately, we are not able to measure 230Th and clay abundances/types, as suggested by referee 2, in the available time (we also do not possess an XRF core scanner), but would find these studies very interesting for further research.

4. Technical Corrections

We would like to follow the technical corrections as suggested by referees. As proposed by referee 2, we will draw the 120 m isobath in Figure 1 and discuss a possible influence of the exposed shelf on TOC content, and delete Figure 2. “902” on page 2264, line 22, will be changed to “602”. Information on the thickness of sub-samples (∼2.3 cm) will be provided in the methodology section, as suggested by referee 1.

Interactive comment on Biogeosciences Discuss., 8, 2259, 2011.

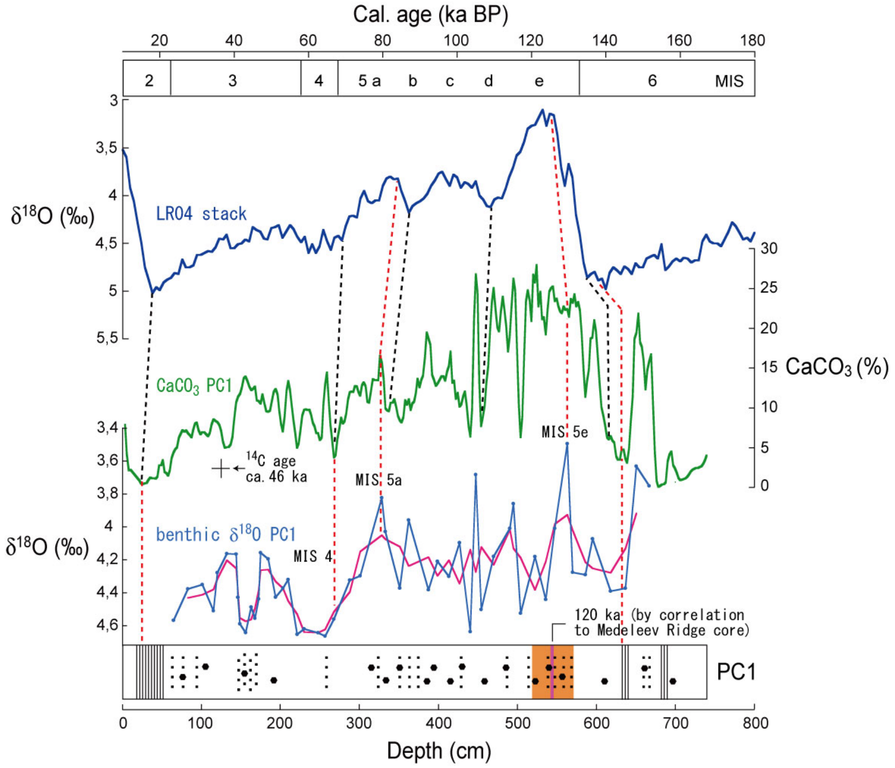

Fig. 1. Fig. S1

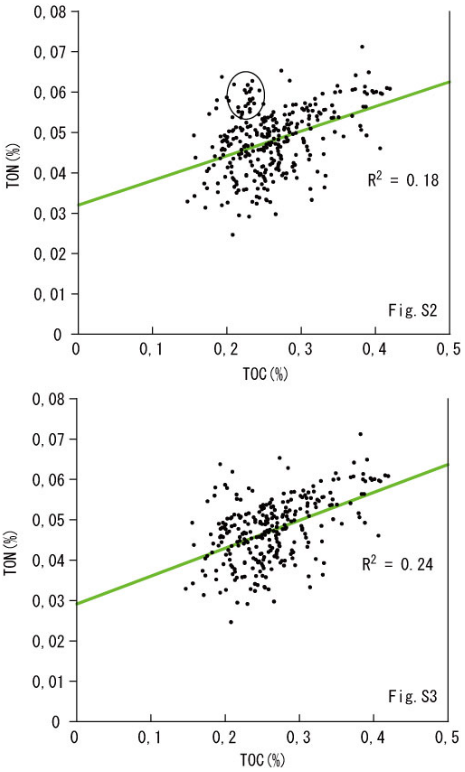

Fig. 2. Fig. S2 and S3

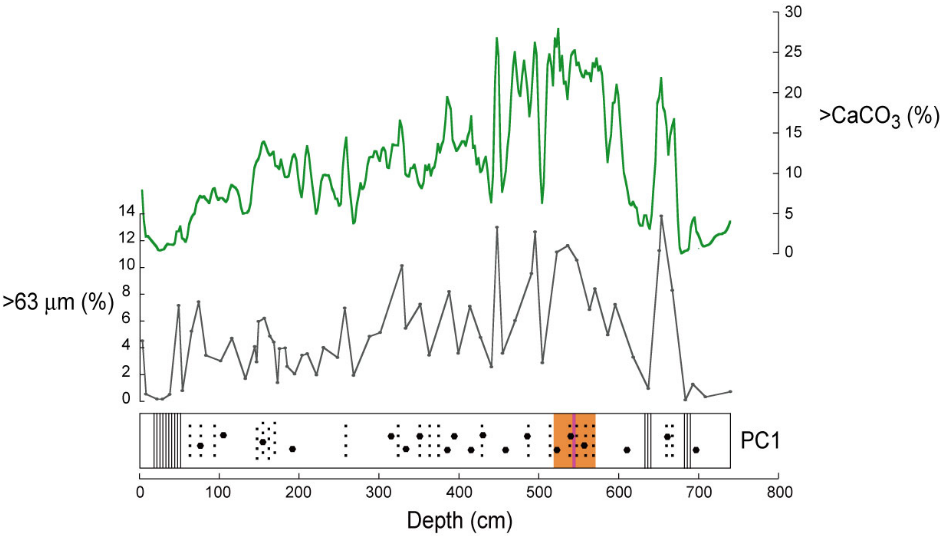

Fig. 3. Fig. S4