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Biogeosciences
Discussions

Interactive comment on "Spatial distribution of benthic foraminiferal stable isotopes and dinocyst assemblages in surface sediments of the Trondheimsfjord, central Norway" *by* G. Milzer et al.

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The manuscript investigates the modern spatial patterns of benthic foraminiferal stable isotopes and dinocyst distribution in a representative central Norwegian fjord. Major target of the study is to test if the complex hydrology and biogeochemical cycling of the fjord system is accurately reflected by the distribution patterns of the investigated proxies. Based on this information, the study aims at testing the potential of these proxies for regional paleoceanographic and paleoclimatic studies. The manuscript addresses up-to-date scientific questions and the topic is in the scope of the journal "Biogeo-

sciences". The manuscript is generally well written and organized. The data set is significant and the relevant ecological, biogeochemical and environmental factors have been critically discussed and comprehensively interpreted. There are a number of minor issues, however, that should be considered in preparation of the final version. Particularly, the influence of the specific microhabitat on the stable carbon isotope signal of the benthic foraminiferal tests and the differential perservation potential of the dinoflagellate cysts under varying sedimentation rates and oxygenation of bottom waters should be addressed in some more detail. These modifications will probably require minor to moderate revision of the manuscript.

General issues

1) You conclude that both dinocsyt assemblages and benthic foraminiferal stable isotope signals in the fjord system can be used as a present analogue for the interpretation of past (Holocene) paleoceanographic and paleoclimatic changes. In this context, it would be interesting to discuss if the present situation actually represents a proper analogue for the past or if you should rather use a pre-industrial situation as reference. It appears likely that anthropogenic land-use recently altered vegetation, hydrology and erosion in the catchment area of the fjord. This would have resulted in deviation from natural fresh water runoff, nutrient fluxes and organic matter input to the fjord. Maybe, you should shortly address this potential bias.

2) When interpreting the stable carbon isotope signature of Melonis barleeanum you should also discuss the potential role of the specific microhabitat of this species. This species may inhabit a range of microhabitats within the fjord system, depending on spatial contrasts of the substrate and oxygen penetration, controlling the organic matter remineralization rate and the position of the nitrate reduction zone. Various studies have shown that M. barleeanum prefers an intermediate microhabitat and appears to be associated with the specific biogeochemical conditions in the nitrate reduction zone (for example see Fontanier et al. 2002, Deep-Sea Research I 49, 751-785). Accordingly, vertical shifts of this zone and accompanied microhabitat change of M.

barleeanum should result in quite some additional variability of the observed stable carbon isotope composition. This ecological preference likely accounts for the variability of the stable isotope signature observed in life specimens (e.g. Mackensen & Licari 2004, in Wefer et al., The South Atlantic in the Late Quaternary, Springer, 623-644). Vertical microhabitat shifts may also contribute to the magnitude of changes observed in past records (Schmiedl and Mackensen 2006, Paleoceanography 21, PA4213, doi:10.1029/2006PA001284). Are there any data available on the microhabitat of this species in the Trondheimsfjord or comparable environments? At least you should extent the discussion of this issue.

3) The potential bias of specific preservation potential of different dinoflagellate cysts should be discussed in some more detail. Spatial and temporal differences in sedimentation rates and oxygen concentration of the bottom and pore waters may influence the diagenetic overprint of the cyst assemblage. Particularly, the preservation of certain heterorophic cysts may be influenced by post-depositional oxidation processes.

Specific issues

1. Introduction: # Second paragraph: - In addition to bottom water, you should also mention pore water characteristics. - you should also mention here that in marginal marine environments the delta18O composition of the fresh water (which depends on the distance to the source area of the water vapor) contributes to the stable oxygen isotope composition of the coastal marine water. - concerning the preservation of dinocysts in marine sediments, you should address the influence of sediment accumulation rate and oxygen content of the bottom and pore water.

2. Physical settings and oceanography: - in this chapter, you should extend the information on the fjord environment, including the average seasonal range in temperature and salinity, as well as information on oxygen content, delta13C of dissolved inorganic carbon of the bottom water mass, and additional sedimentological (sedimentation rates) and biogeochemical information (productivity, TOC, C/N etc.), if available.

Particularly, biogeochemical information would be useful here for proper interpretation of the stable carbon isotope signal of infaunal benthic foraminifers and to assess the preservation potential of the dinocysts.

3. Material and methods 3.2 Stable isotope measurements # do you have any idea on the average living depths of M. barleeanum in the study area? At least you may give a range for the potential microhabitat depth reported in the literature. # do you have any information on the amount and quality of organic matter in the fjord environment? If so, this information would be very useful here.

4. Results and discussion 4.1 Benthic oxygen isotopes # you mention that the investigated surface sediments integrate over the past 4 to 20 years depending on the specific sedimentation rate at the studied sites. This means that the measured delta18O signal at different sites may represent integration over different time periods. In addition, inspection of Figure 2 shows quite some temperature variability on decadal and subdecadal time scales, which then may be represented or may not be represented in the measured specimens. This problem may account for some of the deviations shown in Figures 4 and 5. You should address this in your discussion.

4.2 Benthic carbon isotopes # are there any data available on the delta13C of DIC in the water masses of the fjord? Such information would be very useful for comprehensive discussion and interpretation of the observed variability of foraminiferal delta13C. # second paragraph: you correctly mention the microhabitat and porewater influence on the delta13C signal of M. barleeanum. You should extend this discussion here concerning the relevance for the observed delta13C variability of this species in the Trondheimsfjord. It is a pity that you did not use stained individuals from defined microhabitat intervals for optimum evaluation of this process. # fourth paragraph: you argue that food scarcity on the sill will lead to reduced organic matter remineralization, thus accounting for the observed positive delta13C excursion. In addition, you should mention that food scarcity may also result in a shallower microhabitat of M. barleeanum, thus contributing to the heavier delta13C signal observed.

4.3 Dinocyst assemblages # you mainly attribute the apparent heterogeneity of cyst accumulation in the different parts of the fjord to the effects of winnowing and other sedimentary processes (debris and turbidity flows). Could differential preservation of cysts in different parts of the fjord contribute to this heterogeneity? You shortly mention that diagenetic and aerobic decay can account for preservation differences of certain dinocysts (end of sixth paragraph). This issue appears important concerning the applicability of this proxy in paleostudies. Therefore, you should extent the discussion of the preservation potential of heterotrophic versus autotrophic cysts in the fjord environment and how this could alter the distribution and relative abundance of the different species in the fjord. Are there any data available on the long-term preservation of dinocysts in Holocene sediments of the Trondheimsfjord or comparable environments?

Figures: # Fig. 4: you may consider interpolation between data points. Although it appears straightforward to associate each single station with colors for the respective category, interpolation may enhance the visualization of the trends and spatial patterns. # Fig. 5: the size of the station map in the upper part of this figure should be increased. In the lower part of this figure, station labels may be removed from the dots in the curves since they are also displayed on the X-axis below and above. # Fig. 6: similar to my comment on Fig. 4, you may consider interpolation between data points.

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