

Interactive comment on “Coastal primary productivity changes over the last millennium: a case study from the Skagerrak (North Sea)” by Anna Binczewska et al.

Anonymous Referee #2

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The paper presents two records of benthic foraminiferal assemblages and geochemical analyses from the northern deep Skagerrak region. The records are excellent, presenting high-resolution data for the last millennium. The strength of the paper is especially the fact that data from two neighboring cores are presented, as provides evidence of a general pattern. The paper is overall well-written and clearly presented and I believe that it fits well within the scope of the journal.

However, the ms has a tendency to focus too much on local conditions and comparison to relatively few previous studies. It would therefore benefit from including information from a broader range of study sites as well as from other types of records, including

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terrestrial and lacustrine records. Also more direct comparisons between records as well as an improved precision of the discussion of water masses is needed. Finally, not all data (e.g. Mg/Ca) are actually used to any significant extend in the discussions:

A key element of the paper is the link between the record and the North Atlantic Oscillation (NAO). A number of studies have suggested a more positive phase of the NAO during the MCA and a negative phase during the LIA. However, the here the authors only refer to one study without taking into account that other, earlier, studies have also made this suggestion (e.g. from off Portugal, in the Labrador sea/West+East Greenland etc.). Also, since the present manuscript provides a high-resolution records, these data should in fact be plotted vs. the high-resolution NAO reconstructions (Trouet et al, as well as vs. other high-resolution records such as those by Olsen et al 2012 and Faust et al 2016). It would be very interesting to see, if the overall quite well-known trend of positive NAO during the MCA and negative NAO during the LIA is also seen at shorter, decadal/multidecadal time scales. Whether such a correlation between productivity and NAO cannot be verified, it would be valuable information. Olsen, J., Anderson, N.J., Knudsen, M.F, 2012: Variability of the North Atlantic Oscillation over the past 5,200 years. *Nature Geoscience* 5, 808–812, doi:10.1038/ngeo1589 Faust, J.C., Fabian, K., Milzer, G., Giraudeau, J., Knies, J., 2016: Norwegian fjord sediments reveal NAO related winter temperature and precipitation changes of the past 2800 years. *Earth and Planetary Science Letters* 435, 84-93.

The study region is influence by several different water masses, including local outflow of low-salinity water from riverine outflow, saline Atlantic water and more intermediate salinity water as a mixture of North Sea and riverine waters (e.g. the Jutland Current). However, in the presentation of the water masses, it is not always clear at which levels in the water column these water masses are found, nor whether they also influence the actual study sites. This problem continues throughout the discussion and the one gets the impression that either there is increased Atlantic water or increased low-salinity water. However, stratification could allow both. Thus, the discussion need to be much

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more precise. In this context, I do agree that the increased flux of planktic foraminifera indicated increased inflow of Atlantic water. However, how sure are the authors that the planktic foraminifera are in fact locally produced and not brought in from the Atlantic via the currents? The planktic foraminifera may not be autochthonous and even if they are, they would likely not represent direct surface waters. Thus, this inflow may not have occurred right at the surface, but rather as a subsurface current, thus still allowing an increased surface-outflow of lower-salinity waters. In the discussions on whether the changes in productivity are primarily linked to the influx of Atlantic water or if it could be linked to wind mixing during episodes of stronger winds and/or linked to changes in runoff from land linked to precipitation, it would be relevant to also compare with precipitation data. Here, e.g., studies of mass balance in Norwegian glaciers (e.g. Nesje et al 2000) as well as lake studies would be relevant. Nesje, A., Lie, Ø. and Dahl, S.O. 2000: Is the North Atlantic Oscillation reflected in Scandinavian glacier mass balance records? *Journal of Quaternary Science* 15, 587-601.

Another point to raise is the actual use of the data. The dataset includes benthic foraminiferal assemblage studies, including factor analyses, planktic foraminiferal concentrations (no details on species distribution, so I assume that this was not analyses?), Mg/Ca, Mn/Ca, and stable carbon and oxygen isotopes. However, the geochemical data is only used for calculating bottom-water temperatures, and these temperatures are more or less accepted without any further discussions. The reliability and uncertainty of the data needs to be taken into account. Thus, the discussions on the palaeoproductivity is almost solely based on the benthic foraminiferal assemblages. The benthic foraminifera are good indicators, but since so much more data exist and are presented, they should also be used properly in the discussions.

Finally, despite an introduction trying to build a link between this study and the understanding of the consequences of greenhouse gas emissions, the actual significance of the study region is not clear: Why is Skagerrak relevant? Because it represents an intermediate area between the open ocean and coastal regions? Also the actual

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relevance of the outcome of the study to the problems raised in the introduction is not clear and should be made clear in the conclusions. It is an interesting and relevant study, but please make it clear to the reader, too.

Minor comments:

Latin grammar rules means that the name of the species should be "Melonis barleeanus", not "Melonis barleeanum".

Are you sure that *Cassidulina neoteretis* is present in the material? If yes, this could indicate an high influx of deep Atlantic or even Nordic Sea water.

Page 4, line 25-30: It is not quite clear from the description of the water masses, which ones are surface waters, intermediate waters and bottom waters. One for one water mass is the depth in the water column provided. As the depth of outflowing/inflowing waters is very important, this must be made clear. It also needs to be specified very clearly, which water mass sweep the actual study sites in the deep Norwegian Trench.

Page 5, line 12-15: It should be pointed out specifically that both cores are taken from the deep Norwegian Trench.

Material: please provide a short, overall description of the sediment in the two cores.

Factor loadings are provided and used in the discussions and presented well in the final figure of proxy comparison. However, in order to evaluate the results of factor analyses, the authors should consider actually plotting them vs age in a diagram comparing them to the faunal data.

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