

Dear editor,

We have changed the manuscript according to the most relevant comments of the reviewer 2 (please see Author's final response to comments).

However, when it comes to the last comment regarding which processes have played a role in climate variability during different periods (RWP, DACP etc), we find it too speculative since our study is proxy-based and has nothing to do with modelling, by which it would be more appropriate to address such a question. By using proxy data we can only compare our results to other regional and global studies, which have linked climate changes to one or another mechanism. That is why we shaped our conclusions as they appear in their present form in hope that our dataset can be used by modellers in the future to clarify the role of different climate change drivers during the different periods. We hope that you also see this as wise and thoughtful decision and will accept our choice on how we prefer to present our dataset and conclusions in the paper.

We attach the revised manuscript with markups indicating applied changes as supplement to this submission. A detailed response to reviewer's comments is given below.

Best regards,
Kjell Nordberg and the co-authors.

Author's response to reviewer 2 (Final comments)

We would like to thank the anonymous reviewer 2 for additional comments on how to improve the manuscript. Below we respond to each of the raised points in details.

Minor comment 1:

Introduction: The authors seems to have misunderstood my comment on asking for a better explanation on the significance of the study site. The answered with an extended explanation to the significance of AMOC. This is a good addition, but it would have been nice to get a few words also on why NW European sites are important and why the Gullmarfjorden is especially good. With the addition made this is no longer essential, but would improve the ms.

Response:

There was no misunderstanding, we intentionally expanded the section explaining role of the AMOC and especially the role of its NE limb (North Atlantic Current) delivering heat to Northern Europe, thus underlining the role of NE Atlantic sites in reconstructing climate variability linked to the variability of the N Atlantic Current (and hence AMOC) during the last 2 millennia. Also we write on multiple occasions that Gullmar Fjord provides a unique archive for climate reconstructions not only due to its location in NE Atlantic region but also due to its high temporal resolution caused by high sediment accumulation rates and a winter signal, which unlike to many other locations, here is recorded in foram shells. Therefore we do not think (and as reviewer himself/herself admits that it is no longer essential) that manuscript would benefit from narratively repeating this information several times in the text.

We added though a short statement into the introduction on p.3, lines 20-22:

"Among advantages of the presented record are its high temporal (annual to sub-decadal) resolution and a winter temperature signal, which is unlike to most other proxies is recorded in fjord foraminiferal shells due to specific hydrographic conditions."

Minor comment 2:

§5.1 The RWP: Remember author name for “*Cassidulina neoteretis*” and check that author names have been added to all species (the first time).

Response: This has been corrected to *Cassidulina neoteretis* Seidenkrantz 1995 on p. 13, line 3.

Minor comment 3:

§5.2 The DACP: During the DACP there was warming of subsurface waters off West Greenland (see e.g. Seidenkrantz et al. 2007, Holocene), ascribed to a stronger Atlantic component of the West Greenland Current and a negative NAO.

Response: We added a following sentence to p. 13, lines 25-26: “*Seidenkrantz et al. (2007) also report a warming of subsurface waters off West Greenland during the DACP attributed to a stronger Atlantic component of the West Greenland Current and a negative NAO.*”

Minor comment 4:

Page 17 lower part: please add more detailed explanation to the link between cold AMO phase and cold bottom water – this link may not be logical to everyone.

Response:

There must be a misunderstanding here. As it was emphasized in the report by reviewer 1, on both occasions of the cold AMO (prior to the 1920s and during the 1970s/1980s) we observe WARM bottom water in the fjord (not COLD) and this phenomenon is already explained explicitly on p. 17. Investigating the role of AMO in the variability seen in our record was never a major goal of this paper, since we have a bottom water temperature record, and not a SST record, which would be more directly related to AMO (=SST) variability. Even though the Gullmar fjord deep water originates from the North Sea surface water, we know very little about processes modifying properties of this water mass on its way to the fjord. Hence, to avoid unnecessary speculations we would prefer to not extend this section further.

Minor comment 5:

Conclusions: final 4 lines: can it be concluded which of the mechanisms are most important and under which conditions? Right now, it is rather imprecise.

Response:

This study is based on proxy data, and not on modeling results. By modeling it would be possible to adjust variables and discuss more in depth about different mechanisms which were important and when. By using proxy data, compared to other studies, one can only speculate about one or other mechanism to play a role. Therefore we chose to present our most important results and not to speculate too much about different mechanisms, not least because our dataset ends in 1996 after which species *Cassidulina laevigata* became extremely rare in the fjord, as a result of the establishment of severe seasonal hypoxic conditions in the bottom water.