

Interactive comment on “Changes in Holocene meridional circulation and poleward Atlantic flow: the Bay of Biscay as a nodal point” by Yannick Mary et al.

Anonymous Referee #1

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Mary et al present an excellent new Holocene SST data set from the Bay of Biscay, including a very high resolution last 1500 years. Good reproducibility is shown between cores and at existing study sites off the Iberian margin, and many of the signals are seen in existing work further north, into the Nordic Seas. The figures are clearly presented. There are numerous instances where the language of the text could be improved, since the meaning is either unclear or very oddly worded, however I trust copy-editing will pick these up. Overall, the methods and results are very good, yet the discussion and interpretation could be improved.

My main criticism is that the authors often need to be more specific about precisely what the inferred mechanisms driving the changes are, and what their new insight is.

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The authors draw attention to key findings in the conclusion, but not in the abstract. They interpret their data, alongside existing datasets, as showing regional differences (subpolar versus subtropical) in the timing and trends of temperature trends, notably between Iberian Margin data (subtropical), and the Bay of Biscay and North Iceland (subpolar). More specific and clearly worded conclusions regarding the drivers of these trends would be useful. The abstract needs improving by including specific key findings/results and interpretations. What is the specific important take home message and why is it important? Be precise.

Discussion of the results and inferred mechanistic scenarios are sometimes rather general ("a gyre-specific expression of the AMOC"). Can the authors go further than simply stating there are some regional differences across the North Atlantic (which has been demonstrated by numerous authors over the years (eg Moros et al 2006, PaleO; Solignac et al 2006, PaleO; deVernal and Hillaire-Marcel 2006, GPC; Thornalley et al 2009, Nature; Giraudeau et al 2010, QSR)? And perhaps of more importance, the addition of a discussion into why there is such good coherence between surface SST records between the Bay of Biscay and the North Iceland shelf, yet quite different trends to the sub-seasonal thermocline data south of Iceland (see comment for L198-200 below). Given that very different trends are observed between the surface and sub-surface south of Iceland, it seems likely the answer lies in different controls on surface versus sub-surface changes, as discussed by Thornalley et al 2009 - the subsurface being controlled by SPG dynamics whereas the surface being controlled by other factors. L169-L189 describes these surface changes, including two striking warm intervals, yet there is little discussion about the cause of these events, which are not seen in the subsurface records which are presumably monitoring SPG dynamics. And why is there a good match between the Bay of Biscay SST and the chosen North Iceland Shelf data, but not with numerous other records monitoring the eastern inflow of Atlantic water to the Nordic Seas (see comments for L83-188 below)?

This manuscript could be greatly improved with a little bit more thought and time spent

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on drawing out the main mechanistic ideas and how they integrate with broader concepts and existing datasets of North Atlantic Holocene change – trying to be as precise as possible. I strongly encourage the authors to take such efforts since they have a very nice dataset to add to this debate, however, I would find it acceptable if it were published with only minor to its present form, since it does not, in my opinion, have any major factual inaccuracies and does an adequate (albeit limited) job of placing this dataset in context with some existing studies.

More specific comments:

L24: Is the Bay of Biscay a nodal position? How so? Often frontal shifts are envisaged shifting about a modal position of Newfoundland...

L30: I question whether this study actually offers unprecedented resolution (I would remove). Perhaps unprecedented for Bay of Biscay, but certainly not for the North Atlantic

Abstract: More generally this should also include a summary of the key findings, rather than just a brief description of the study site and methods.

L37: I find the implication that the AMOC controls the 'frequency' of climate over Europe confusing - what do you mean specifically (and cite ref.)

L46-48: This sentence uses a lot of jargon to say very little.

L47-49: the relevance of this sentence to the study is not that obvious.

L56: why is the Bay of Biscay ideally located? One could argue that sites further NW are closer to the STG/SPG boundary and so more sensitive to monitoring these changes.

L139: provide reference for support

L183-188: There are of course numerous other SST records available from the Nordic Seas under the path of the Inflow and NwAC (eg Risebrobakken et al 2003, Giraudeau

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et al 2010, Rasmussen and Thomsen 2010) that have not been shown, many of which do not show similar patterns to the Bay of Biscay SST data. It would be interesting to think more about these different records, and more specifically why the Irminger Current/North Iceland shelf shows similar trends to the Bay of Biscay, but not the Faroe branch of the NAC (or at least a more mixed signal is seen in the NwAC and Barents Shelf), especially since one might initially expect a more direct link between the eastern limb extension of the NAC and the eastern located Bay of Biscay.

L198-200: This is incorrectly worded; more care is needed. The density anomalies in Thornalley et al are a combination of changes due to SPG driven changes in the seasonal sub-thermocline, and other changes in the surface water. Changes in the G. inflata record alone were interpreted as a SPG strength proxy, not the density difference, as plotted by Mary et al. Perhaps a case could be made that by taking the difference between the surface and the sub-thermocline layer removes any larger scale changes in SST and SSS, and helps isolate the SPG strength signal, although this would be at odds with Fig 3 in Thornalley et al 2009.

L203: The assertion that changes in density anomalies reported by Thornalley et al 2009 are synchronous with cold spells in Mary et al's record is unconvincing. Major features are sometimes in phase or out of phase. (The match between periods of storm activity and the SST data of this study is also not that striking.) This is not a major weakness in the paper, and perhaps it simply reflects that the Bay of Biscay SST is only weakly sensitive to expansion/contraction of the subpolar gyre, and at times these signals are dominated/swamped by other controls (perhaps of a more local origin, or of subtropical origin). Or the surface temperature records are less sensitive for monitoring changes in subpolar gyre dynamics than deeper thermocline records. Perhaps it would be worth adding such a caveat, rather than stretching the data comparison too far and inferring close relationships when they don't seem convincing. Yet the similarity between the Bay of Biscay SST and the North Iceland Shelf records is good. The question is therefore how to explain the coherence between the Bay of Biscay and

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North Iceland SST records, and the different trends seen in the sub-seasonal thermocline data south of Iceland. Given similar differences are seen between the surface and sub-seasonal thermocline records at the same site south of Iceland (and if anything, the surface temperature data at this site looks more like the Bay of Biscay and North Iceland SST data – albeit not the similar!), rather than the explanation being found in regional differences, it is perhaps likely that it is to do with surface versus subsurface changes.

L210: please explain this inferred atmosphere-ocean interaction - be more specific.

L294: 'a decoupling of subpolar gyre dynamics' from what? This is unclear.

L300: please use alternative phrase to 'gyre-specific expression' – in essence you mean there are differing SST changes and trends in the subtropical and subpolar regions (or at least at the sites you discuss).

L312: unclear. What is meant by 'contrasted patterns'?

Technical corrections: L23: add 'in the subpolar North Atlantic to the end of first sentence' L34-35: remove this sentence - it adds nothing, and just reads oddly L49: 'rightly' should be 'correctly' L95: replace 'onwards' with 'using a' L173: please refer to figure panel this relates to L191: replace '-1oc' with '1oC cooler', otherwise it might be misread as if the temperature was -1oC! L283: replace 'extensions' with 'expansions' L605: add labels for what blue triangles are to figure caption L630: the plot is the density difference between the near-surface and base of the seasonal thermocline, not density anomalies at sub-thermocline depths as written in caption.

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