

Response to Short Comments from Referee #4 (Jenny Jardin)

Ref #4: *This paper was the subject of a journal club discussion at the National Oceanography Centre. Main conclusions suggested a weakened Gulf Stream during the late 1960s-70s and since the 1990s that long-term trend analysis using Ensemble Empirical Mode Decomposition (EEMD) correlated to the AMO and AMOC. The manuscript further concluded that the reconstruction was able to adequately capture the regional sea level variability in periods longer than 5 years.*

Response: The referee is thanked for her minor comments and suggestions, and we appreciate the attention given to this study by UK/NOC's scientists. NOC includes many experts on sea level rise, climate change and scientists monitoring AMOC with the RAPID data used here. I must admit that numerous studies I published using the AMOC data were motivated by and evolved from interactions I had with NOC scientists during a sabbatical I spent in Southampton some 6 years ago, so thanks again, T.E.

Ref#4: *There is some doubt on the statistical confidence of the EEMD method, given that there are two low frequency oscillations being compared and there is no mention of how many Degrees of Freedom were used to assess the significance of results. As a group, we felt that more description is needed of the EEMD methodology and more confidence that results presented are statistically significant.*

Response: Following similar suggestions from Referees #1 and #2, the revised manuscript provides more details on the EMD method and the statistics used to estimate the degrees of freedom and confidence levels of low frequency EMD modes (lines 158-167). A new reference on the statistics used was also added (Thiebaut and Zwiers, 1984).

Ref#4: *In Figure 2, there is a distinct lack of sea level variability before 1940 that looks a lot like artificial smoothing. We anticipate this is due to the lack of data during this time period, but this needs to be acknowledged in the main text. Another suggestion is to run the model with random sub-sampled data after 1940 to have a more constant data input. This could show if the increased variability is dependent on the number of data points.*

Response: The referee is correct in the assumption that lack of data at the beginning of the record (no altimeter data and fewer tide gauges) is likely the cause of decrease variability at that time and this is acknowledged in the paper. The original reconstruction paper (Dangendorf et al., 2019) further evaluated the variability, but this is beyond the scope of this paper and would not affect the main results here.

Ref#4: *The manuscript also needs a clearer structure. The main conclusion, which reads as the long-term variability in the Gulf Stream, is an interesting result but is quickly lost in the middle of the paper, when the focus shifts to evaluation of regional sea level. One suggestion would be to put Section 3.2 just after the methodology, and then ending with the long-term Gulf Stream variability with AMO/AMOC.*

Response: Following a similar suggestion from Referees#1, we indeed changed the entire organization of the paper and the order of sections and figures to make it more logic and readable (very much like what Ref#4 had suggested; see response to Ref#1).

Ref#4: *. Line 104: a brief explanation of the ocean dynamics mentioned would be useful.*

Throughout the manuscript, a more detailed (though still very brief) description of processes would be preferable when listing several references to explain a point. Section 4: this is a very detailed/lengthy section that could benefit from some further summarisation. Much of the information here would be best going into the introduction or discussion sections

Response: The new reorganization and text editing largely took these comments into account.

Ref#4: *Fig 1: the jet colour scheme is slowly being phased out, due to the sharp colour contrasts. Suggest using another colormap. Fig 2: the red-green lines in 2b (and other figures throughout the manuscript) may be difficult for colour-blindness. Suggesting using different colours.*

Response: Thanks for the suggestions. In fact, the first author himself is a long-time color blind scientist who is well aware of these issues, but in this particular case he found the figure colors clear enough for his eyes...