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Author Response:

I thank Anonymous Referee #3 for posting a very helpful review of the paper. The referee comments were very minor in nature. In the revised paper, I have addressed all of the comments brought forward by the reviewer and this has improved the paper.

My responses are interspersed with the comments by the referee (in black), and I have used indented blue Arial font for ease of review.

General comments

The Bermuda time series ocean observations of carbonate chemistry such as those at BATS are invaluable as they record variations in response to anthropogenic car- bon dioxide emissions and ocean climate variability. They become progressively more valuable with each additional year of observations. Therefore refreshed interpretation of the time series results merits publication at intervals.

Here, Bates describes the long term changes in the subsurface water mass Subtropical Mode Water, STMW. The analysis conducted is thorough, it brings out evidence for the most important anthropogenic, physical and biological processes that need to be considered in connection with the variability. Of particular interest is the connection with the North Atlantic Oscillation, NAO. The schematic explanations expressed in Figure 3 and 4 are most useful.

This is a very detailed work, at times it becomes heavy reading and there are several issues which need to be clarified. After revision this work fully merits publication.

An important general issue which needs clarification is the data set being evaluated. It is clear from Section 2 on methods and materials that the data for the paper is the Bermuda Atlantic Time Series, BATS, from 31˚40'N, 64˚10' W, and that it goes back to 1988. In the heading for Table 1 reads, "Long-term trends (1983-2011) of STMW . . . ." , but the periods listed all begin 1988. In the heading for Table 2 reads, ". . . . From the BATS (31˚50'N, 64˚10'W) site . . . ." , but most of the periods listed in the table begin 1983. The time line in Fig. 1 starts at 1988 but the legend for Fig. 1 reads "from 1983 to 2011 at the BATS (Bermuda Atlantic Timeseries Study; 31˚40' N, 64˚10' W) and Hydrostation S (32˚10' N, 64˚30' W) sites located near Bermuda in the NW Atlantic Ocean". For Fig. 2, the graphic time lines starts at 1988 but the legend reads " from 1983 to 2011 at the BATS (Bermuda Atlantic Time-series Study; 31˚40'N, 64˚10' W) site located near Bermuda in the NW Atlantic Ocean ". It should be made quite clear whether Hydrostation S, which bridges 1983 to 1988, is part of the BATS time series or not, and the tables, figures and text corrected acccordingly.

My apologies for including reference to 1983 in the text and legend. This should have been 1988. This is corrected in the revised paper. I will also clarify that BATS data only was used in this analysis.

In this paper the connection with NAO is in focus and comparisons are made with another study on NAO by Levine et al. (2011) where Bates is a co-author. In the Levine et al. paper the NAO index is the station based wintertime NAO record for 1970–2004 compiled by James Hurrell (National Center for Atmospheric Re- search, Boulder CO USA, http://jisao.washington.edu/data_sets/nao/). Here, however, the NAO index data has been obtained from the NOAA Climate Prediction Of- fice (http://www.cpc.ncep.noaa.gov/products/precip/CWlink/pna/nao index.html). Why is this choice made for the NAO index? Does it significantly influence the results, in particular the comparison with the Levine et al. (2011) paper?

The choice of NAO index does not significantly impact the results. I used the CPO data as this is consistent with usage in previous papers, and is also up to date until the end of 2011.

In the methods and materials section one more subsection should be added to explain the method applied for defining the mixed layer depth, MLD.

Details about calculation of MLD is now included.

Specific comments

P12454, Line:17 Marshall et al., 2004: This reference is not listed.

The reference is now added.

P12455, Line: 19 The reference Bates et al. 2011 is a submitted manuscript, but not published. It is 4 times referred to, once to a figure there. It decribes the results from surface observations and closely related to the present manuscript. It is inconvenient not to be able to examine the surface results.

The reference to the companion paper in Biogeosciences is clarified.

P12456 Line:15 Replace > with more than.

This is corrected.

P12456 Line: 20 Does the ~ symbol mean ±? Please explain.

This is corrected in the revised paper.

P12456 Line:11 “Here this term” What do the words this term refer to?

This is corrected in the revised paper.

P12459 Line:15 The calculation of the term +1.06 μmol kg−1 yr−1 requires better ex- planation.

This is better explained in the revised paper.

P12459 Line:14 What does 30 stand for?

This was a typo and removed.

P12460 Line:16 Please write more clearly the description of the three terms in eq 3, avoiding phrases like “changes due to changes”.

This is better explained in the revised paper.

P12460 Line: 22 Arrange equation terms in same sequence as in the description of the terms above.

Yes, that is a good idea, and undertaken in the revised paper.

P12462 Line: 1 and 2 Considering the cumulated errors, is the the term 0.16 of signifi- cance? Suggest adding “may” before contribute in line 1.

Yes.

P12463 Line: 2 Correct reference Bates et al., 2022.P12466 Line: 2 The reference Andersson et al. can not be found. P12467 Line: 33 Correct the title of this paper.

The references are corrected.

P12470 Line: 7 Change 31˚50’N, 64˚10’ W to 31˚40’N, 64˚10’ W.

This is corrected in the revised paper.

P12471 Line: 7 Change 31˚50’N, 64˚10’ W to 31˚40’N, 64˚10’ W.

This is corrected in the revised paper.