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**Author Response:**

I thank Anonymous Referee #2 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 blue Arial font for ease of review.

Review of Bates 2012, Biogeosciences

In this paper, the author uses observations at BATS from 1998-2011 to assess changes in CO2 uptake by subtropical mode water (STMW), with primary attribution of changes to the North Atlantic Oscillation (NAO). The contribution is appropriate for Biogeo- sciences, and I recommend major revisions that focus on a better assessment of un- certainty, directly addressing lateral advection time from the STMW outcrop to BATS, and providing a better spatial context for the processes involved.

General comments 1. To estimate the impact that change in STMW formation has on the DIC concentration, the author (1) assume that the trend in DICanthropogenic is equal to that implied from the long-term trend in the atmospheric pCO2 (70%), (2) that all enhancement of mesopelagic remineralization due to increased primary productivity (Lomas et al. 2010) occurs in STMW, giving 20% more of the trend, and then (3) the remaining 10% is due to change in STMW formation. This is a very rough estimate, and the remaining fraction is quite small. The author needs to provide uncertainty estimates for each assumption and discuss in more detail the ability to assess STMW formation based on these data in the context of this. Uncertainty should be presented in Figure 4.

The referee makes a valid point about addressing uncertainty. In the revised paper, I add statements about the uncertainty of these estimates. The error associated with term 1 is small, but is much larger for term 2.

2. How long does it take for mode water outcropped to reach BATS? Only the south- ern reaches of the formation region reaches BATS, and this will only be approached in some years, so instantaneous communication with the surface can't be assumed in all years. This needs to be accounted for in the analysis. Change in communication / advection timescale between positive and neutral/negative NAO needs to be considered.

The referee makes a good point about the outcrop and timing of water to reach the BATS site. In some years, STMW is formed close to Bermuda. In most years, is seems that the lag is 1-2 years, and this uncertainty is accounted for in the revised paper. Unfortunately, given that we do not have tracer age data, caveat statements are added to the paper.

3. The author neeeds to clarify the discussion of surface BATS and STMW at BATS. Is it a

direct connection or is it remote? Figure 3 suggests remote, but other discussion suggests direct. At what depth is STMW at BATS? Please provide a plot of long-term mean and variability of this depth. This will help connect discussion of MLDs/NAO, surface/STWM connections. Also, please include a map with the STWM outcrop and the BATS location.

The revised paper discussion about surface and STMW is clarified. The typical depth of STMW at BATS is added plus a map (with approximate area of STMW outcrop based on Marshall et al., 20009).

Minor comments

Page 1, Abstract " It is estimated that the sink of CO2 into STMW) was 0.985 +0.018 Pg C (Pg = 1015 g C) between 1988 and 2011 (~70% of which is due to uptake of Cant" Comment: Please put this number directly in context of whole north Atlantic sink, or at least the subtropical gyre (for example, Takahashi et al. 2009)

This is clarified in the revised paper.

Page 2, "Thomas et al., 2007; " Comment: Thomas et al 2008 GBC is better reference for open north atlantic than Thomas et al 2007 (north sea)

This is clarified in the revised paper.

Page 3 – discussion of the region - Need a map here to identify outcrop and BATS locations. Discuss transit times for lateral advection from formation region to BATS.

A map is added to the revised paper.

Page 6, " During a few cruises, total alkalinity was not determined analytically, and it was computed from salinity with an error of ~2.8 !mos kg-1 (Bates et al., 1996). "

Comment: Please include alk-SSS equation here

The TA-Salinity equation is added to the revised paper.

Page 8: "higher than the increase in atmospheric pCO2 observed over the same period (Bates et al., 2011). " Comment: Please quote the atmospheric trend of pco2 here, instead of referring to another paper

The rate is included in the revised paper.

Page 8 " Thomas et al. (2009)" Comment: Thomas et al 2008 (not 2009), I believe

Yes, this is changed.

Page 9, Comment: "emplace" is odd word choice

Yes, I agree, and another term is used.

Page 10, " over the last 2 decades, the STMW has been a quantitatively important additional CO2 sink term in the sink- source CO2 budget of the North Atlantic Ocean. " Comment: Provide quantification against other studies, so as to show it is substantial

Yes, I agree, and comparisons are included.

Page 10, "The &DICanthropogenic/t1988 2011 term was estimated earlier at 1.06 !mol kg-1 yr-1, " Comment: Author is assuming that it's keeping up with atmosphere. Dis- cuss evidence and uncertainty

This is discussed in the revised paper, and uncertainty included.

Page 11, "The increase in DIC due to enhanced remineralization is estimated at ~0.29 +0.05 !mol kg-1 yr-1 (i.e., &DICbiology/t1988-2011) or approximately 19% of &DICSTMW/t1988-2011. " Comment: Please explicitly state how the enhanced remineralization of dic number derived.

This determination of remineralization of DIC is now included.

Page 12, "Despite these caveats, it appears that increase in DICSTMW due to changes at the STMW outcrop (i.e., term 2, &DICoutcrop/t1988-2011) contribute the remain- ing 10% to &DICSTMW/t1988-2011 (i.e., &DICoutcrop/t1988-2011 = 0.16 = 1.51- [1.06+0.29])." Comment: When the outcrop part is, by difference, only 10% and the biology part is crude to get 30%, need to address uncertainty from the 70% anthropogenic to this point

This is added in the revised paper.

Page 12, "Notably, a significant decline in DICSTMW was observed in 2011 that coin- cides with a strongly negative NAO (JFM) winter phase (Fig. 1f; 2b). " Comment: This implies an instantaneous transfer of the signal from the mode water formation site to the BATS site. Levine et al. (2011) discuss a 2yr lag of the NAO signal to subtropical gyre, and then there is the issue of lateral advection in the mode water itself. Please discuss how long this should take and how it influences results.

This is added in the revised paper.

Page 13, "DO and nitrate decreased(increased)" Comment: "DO decreased and nitrate increased"

Yes, this is restated.

Page 25, "Figure 1 . . .. surface . . ." Comment: Text suggests this should be stmw. Please make sure it is stmw, and correct references to tables herein

This is corrected in the revised paper.

Page 28, Figure 2: please add to dark green, light green a small label indicating surface and stmw

The figure is modified in the revised paper.

Page 29, Figure 3 – Please include the approximate latitudes and depths (or ranges) that are implied for this schematic.

The figure is modified in the revised paper.

Page 30, Figure 4 needs units on the vertical axes and labels for the DIC component on the horizontal axes. Include uncertainty estimates.

The figure is modified in the revised paper.