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Comment

## ***Interactive comment on “Observed decline of the Atlantic Meridional Overturning Circulation 2004 to 2012” by D. A. Smeed et al.***

**D. A. Smeed et al.**

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In the present manuscript, the authors analyze the currently available RAPID time series with respect to changes in the magnitude and structure of the Atlantic meridional overturning circulation (AMOC). They find a reduction in magnitude over the last four years of observations, which can be mostly attributed to a strengthening of the upper mid-ocean transport, and is balanced by a decrease in the Lower North Atlantic Deep Water, while the Upper North Atlantic Deep Water remains almost unchanged. The manuscript presents novel and interesting findings. It is overall easy to read and very understandable. I recommend the manuscript for publication after a few minor changes.

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Thank you for your comments. We have revised the manuscript in the light of the reviews and the comments have helped us improve the paper. In addition to the changes to text indicate in the responses to the referee's questions we have made the following changes:

- Revised Table 1 to include annual average values for UNADW and LNADW.
- Revised Figure 4 to show contribution of western and eastern boundary to the transport per depth profile.
- Revised Figure 6 to show change in density on the eastern boundary.
- Revised to figure 7 to adjust the (arbitrary) offset in the accumulated NAO.

1) Section 3.1: Has a t-test also been performed for the period including 2009? Also, would it be possible to indicate significant changes in Table 2 (maybe in italics)?

Results both excluding 2009 and including 2009 are shown in table 2. The text in section 3.1 did though only refer to a t-test being applied to data excluding 2009. This was misleading and the text has been clarified.

2) Page 1624, line 22: Maybe state that the reasoning behind choosing 35 degrees of freedom is explained in the next paragraph?

We have changed the order of the paragraphs as suggested by referee 1.

3) Page 1624, lines 24-26: Not clear what "those results" refers to.

We now refer to table 2

4) Section 3.2: Values for the period excluding 2009 are listed in Table 3, but not mentioned in the text?

A comment has been added to the text

5) Figure 6b appears in the text before Figure 6a does. Maybe change the order of the figures?

The order is changed.

6) Page 1627, lines 11-18: If a longer time series is needed to identify reductions due to anthropogenic forcing, then agreement with the results from Thomas et al. cannot be expected?

It is the magnitude of the trend rather than the mechanism of the change that determines the length of time series required to detect the trend. We have modified the text to make this clear. We think the comparison with Thomas et al., (2012) is worthy of note.

7) Page 1627, line 20: There is an 's' missing at the end of 'year'.

Changed.

8) Page 1628, lines 9-22: For me, Figure 7 and this paragraph do not seem to contribute to the manuscript, as the only conclusion seems to be that available data are not adequate for a comparison with climate indices and longer observations are needed.

Figure 7 illustrates when the RAPID observations were made in context of the decadal changes of the North Atlantic climate. As highlighted in the response to reviewer 1 this

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is particularly important when comparing the RAPID timeseries with other observations made at different times.

9) Page 1628, line 28: I think it would be worth citing the Atkinson et al. (2012) paper again, for the values adjusted for seasonal variability.

We have added a citation to Atkinson et al. here too.

10) Generally, I am not sure how valid the comparison with the Bryden et al. paper is. For the hydrographic section data, the weakening of the LNADW cannot be a manifestation of a reduction of the AMOC, as there is no significant reduction of the AMOC after the values are adjusted for seasonality. Also, the timescale is very different, and you say yourself that the reduction seen the RAPID data is probably part of a “cyclical change” and not necessarily a long-term trend.

We agree with the reviewer’s comments and have removed the reference to Bryden et al.

11) Figure 7: I would prefer positive values on the depth axis.

We assume this refers to Figures 4 and 6. The minus signs have been removed from the depths on the y-axes.

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Interactive comment on Ocean Sci. Discuss., 10, 1619, 2013.

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