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Interactive comment on "Compensation between meridional flow components of the AMOC at 26 N" *by* E. Frajka-Williams et al.

Anonymous Referee #1

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Title: Compensation between meridional flow components of the AMOC at 26°N

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This paper examined the correlations between the different components of the Atlantic meridional overturning circulation (AMOC) measured at the RAPID array along 26degN across the Atlantic basin for 10 year, April 2004 - March 2014. The primary findings are: (1) the Florida Current (FC) transport and the upper mid-ocean (UMO) transport are

highly compensated on sub-annual timescales, (2) Ekman transport is strongly compensated by the Lower North Atlantic Deep Water (LNADW) transport again primarily on the sub-annual time scale, and (3) and the changes in UMO transport, which is associated with the isopycnal displacement near the western boundary, is responsible for the interannual and longer variability of MOC. I personally think this paper is one of the most exciting and clearly written papers based on the RAPID data. Kudos to the RAPID team for continuing to produced such an interesting and valuable paper even after so many papers over the years.

Major comments

A. The authors used definitions of the UNADW and LNADW based on depth rather than density. The depth-based definitions make it almost impossible to compare the transport estimates reported in this paper against the other transport estimates of UNADW and LNADW, which are almost always based on density, e.g. the estimates at the Line-W (Toole et al. 2011). I guess that the decision to use the depth-based definition may be due to lack of measurement for the density structure in the interior. However, the geostrophic transport of a density layer is technically only based on only the end points, same as the geostrophic transport of a depth-based layer. In addition, the isopycnal surfaces are mostly flat in the interior of the basin anyway. So I think the authors should at the very least provide the density-based transports along with the depth-based estimates to allow a comparison with the other studies.

Toole, J. M., R. G. Curry, T. M. Joyce, M. McCartney, B. Pena-Molino, 2011. Transport of the North Atlantic Deep Western Boundary Current about 35N, 70W: 2004-2008, Deep-Sea Research II., 58, 1768-1780

B. One of the most interesting findings in this study is that the strong compensation between the sub-annual variability of UMO and FC observed in the full 10-year record is absent in the first 3-years, as previously reported by Kanzow et al. (2010). However, the authors only briefly discuss about this apparent non-stationarity with the Figure 10.

I think a further examination of this non-stationarity may provide some hints about the mechanism involved in the compensation. How unusual was the first 3-years statistically? Perhaps the authors could examine the 3-year running window correlation to quantify how unusual the first 3-years was. Furthermore, the authors suspected the eddies to be responsible for the compensation. If so, does an independent measurement of eddies in this region, e.g. EKE from the satellite altimeter, exhibit a reduced activity during the first 3-years? Please examine this interesting aspect a bit further.

C. Another aspect that may deserve a further investigation is the role of the wind stress curl forcing in the reported compensation, which may shed a light on the respective roles of the barotropic and baroclinic components in the observed compensation. The 0.5 - 1 day lag (Fig. 6e) may indicate a dominant role for the barotropic component. If so, does the wind stress curl averaged along the 26degN exhibit significant correlations with UMO, FC, and Ekman transports? Or does the power spectrum of the wind stress curl averaged along the 26degN exhibit a similar structure as the coherences shown in the Figs. 9-10? On the other hand, the concentration of the compensation near the western boundary may suggest a role for either the baroclinic response to the local wind stress curl or the barotropic response along the western boundary topographic wave guide. These aspects could be investigated based on the correlation of the transport components with the wind stress curl in different locations.

Detail comments

1. Please add the horizontal and vertical grid lines in all the time series plots, e.g. Fig.1, to aid the readability of the plots.

2. P.2711, L.8-11: Please quantitatively compare the first and last 5 years in terms of the number of days with flow reversal.

3. P.2711, L.15-17 and Table 1: Are the mean transports still statistically significantly different if the two periods are divided as 2004-2010 and 2010-2014? This could be one way to assess the robustness of the long-term transport reduction in the record.

4. Figure 4 caption: It seems the data plotted in the panels c-d are not de-trended, unlike the panels a-b. However, this is unclear in the caption.

5. Figure 4a and the related text: The UMO has the sum of three components, i.e. Twbw, Tint, and Text (Eq.1). What are the correlations of each component against the FC?

6. P.2716, L.9-20: The argument in this paragraph could be more straightforward if the correlation of the Twbw, Tint, and Text against the Ekman transport is explicitly provided.

7. P.2717, L.11: "(1500-bottom)" -> "(1500 m – bottom)"

8. Figure 7b and the related text: As 3000 m is about the height of the Mid-Atlantic Ridge (MAR), shouldn't the MAR sub-arrays also be considered?

9. Figure 8a and c: The colors for the curves indicated in the legends and the y-axes do not match. For example, the y-axes for the depth are in black, while the curves for the isopycnal displacement are not in black.

10. Figure 9 and P.2718, L.15-19: The coherences between FC and UMO as well as that for LNADW and Ekman transport are not significant for the periods shorter than $\sim$60 days. What is the explanation for this high frequency cut-off?

11. Figure 10 caption: Are the arrows shown only when the co-spectra are statistically significant? Please clarify in the caption.

12. Figure 11 caption: "Eq. (2)" -> "Eq. (3)"?

Interactive comment on Ocean Sci. Discuss., 12, 2705, 2015.