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Ocean Science
Discussions

Interactive comment on "Atlantic Transport Variability at 25° N in Six Hydrographic Sections" *by* C. P. Atkinson et al.

Anonymous Referee #2

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General Comments:

This study seeks to assess seasonal and shorter time-scale variability in transports crossing 25 N in the Atlantic by mining an existing dataset (the Rapid-WATCH array), which complements hydrographic data from 6 occupations of this line over half a century. It also presents analysis of the latest (2010) hydrographic section, for the first time. At issue is whether or not individual sections represent annual average conditions: this assumption was the basis for Bryden et al.'s (2005b, see paper) conclusion that long-term weakening (interannual to decadal) of the AMOC had occurred from 1957 to 2004. The Rapid-WATCH program was designed to measure variability of the AMOC as observed along 25 N, by collecting a variety of data types continuously for 5 years. This makes it suitable for investigating seasonal and shorter term variability in

meridional transports contributing to the overturning circulation. In particular, the authors focus on the uncertainty associated with the mid-ocean baroclinic flow field. This is an appropriate and resourceful application of the Rapid-WATCH dataset to address a common problem with one-time hydrographic trans-ocean sections.

The analysis of the 2010 hydrographic section indicates that the overturning has regained strength compared to 1998 and 2004. To delve more deeply into the changes, the authors divide the water column into more or less standard water mass components (by depth or potential temperature), and conclude that the deeper layers may indeed have experienced long-term change that is detectable beyond the short-term signals. This result and the newly presented 2010 analysis constitute an important scientific contribution and thus the paper merits publication.

Analysis of the hydrographic sections follows well established methodologies to assign reference levels in the mid-ocean and to account for Ekman transport and flow through Florida Straits. Mass is balanced with a section wide constant reference velocity in mid-ocean. I would be curious to know how much these adjustments (shown in Table 1) change the ref. level of zero velocity, though it is not necessary for the work presented here. However, I am a bit confused as to what happened to the 0.8 Sv of net transport (from Bering Strait): Tables 1 and 5 seem to indicate exact mass balance for the sections.

The primary focus of the paper is on evaluating the uncertainty in the mid-ocean baroclinic flow field using the Rapid-WATCH data. The analysis is relatively straightforward, but some of the results are less than convincing. I found section 3.1.5 difficult because the zonal structure being described is pretty hard to make out on the corresponding figure 9, where all the curves are quite noisy. A stronger result is that transport variability for the UNADW lies outside the seasonal signal range; and the removal of the seasonal bias does NOT change the weakening trend in LNADW in later years (though it still lies within seasonal variability limits). The authors are careful not to overstate their case, and instead "suggest" that real change has occurred and warrants continuing

investigation.

The analysis of transport in potential temperature classes, and of water mass changes, is useful because water mass properties in the deep water would generally be less affected by seasonal transport variability. The observed changes are consistent with the larger picture in the North Atlantic, as detailed in the Discussion section, with decadal evolution of the DSOW as well as the LSW. The Conclusion section is geneally strong, clearly summarizing earlier detailed analysis, though I question the phrase, "as significant reduction in LNADW transport in the late 1990s and 2000s is seen without this being applied," since earlier in the presentation it is clearly stated that the variability lies within the seasonal limits. I suspect "significant" is not being used in its technical sense, so perhaps a different word should be substituted ("substantial"?).

Overall, the paper covers a lot of ground and makes a significant (!) contribution to the literature on the AMOC. But parts of it are confusing (see Technical Comments) or unconvincing, and the text should be tightened up before publication. Additionally, Figures 8 and 9 could both be improved (see technical comments for Figure 8). Figure 9 might be more persuasive if the vertical axes were elongated a bit.

I recommend accepting the manuscript subject to these minor revisions and technical corrections below.

Technical comments:

p. 109, line 17: delete "which forms" and replace it with a comma instead

p. 110, line 5: 2 uses of "design" - replace second with "meant" or "intended"

p. 114, line 7: Table 5 is mentioned before any other table line 8: "arrises" should be "arises"

p. 115, 1st para.: discrepancy between Table 3 and Figure 4: is top layer defined by 22.5 or 24.5 deg. C?

p.115, line 18: sign on 17.6 is wrong - should be positive, not negative

p. 117, line 13: insert "the" before "Ekman"

p. 118, line 25: seriously??? hyphenating UNADW? Hopefully this will magically go away

line 28: "southward" - no "s" at end

p. 119, para. on lines 1-14: very confusing discussion: seem to be switching back and forth between mid-ocean and total transports (for upper water), and also use both "high" and "record low" with "southward" to mean the same thing, I think - i.e., large in magnitude. Just needs some reworking for clarification.

p. 120, line 21: maximum (singular - not maxima)

p. 122, line 16: minus sign stranded at end of line

p. 127, line 5: specify in text that Figure 11 is mid-ocean (even though it's in caption as well)

p. 130, line 24: talking about Figure 13a, you say something about the 4 -5 degree class, but Figure 13a only goes up to 4.5 deg C.

p. 134, line 29: mechanisms (misspelled)

p. 145, Table 3: the corresponding figure shows 24.5 as the boundary, not 22.5

p. 147, Table 5: in caption, 2nd to last sentence, maybe write "mean transport/seasonal cycle (upper), std. dev./std. dev. with seasonal cycle removed (lower)."

p. 153, Figure 6 caption, line 2: sections (plural)

p. 156, Figure 8 - really have to blow it up to see the black lines, and even then they are largely obscured by the heavy red curve. Is there some way to improve this?

Interactive comment on Ocean Sci. Discuss., 9, 105, 2012.