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## ***Interactive comment on “Impact of a 30 % reduction in Atlantic meridional overturning during 2009–2010” by H. L. Bryden et al.***

### **Anonymous Referee #1**

Received and published: 17 April 2014

General comments: In this paper, H. Bryden and co-authors quantify the strength and duration of the AMOC slowdown (30%) observed in 2009-2010 at 25°N and evaluate the impact of this slowdown on the heat content north and south of 25°N as well as probable atmospheric consequences. The paper is concise and rather well written. It addresses a new and interesting question regarding the impact of the 2009-2010 AMOC slowdown on heat content changes and upper layer temperature changes. The main issue that needs to be address is the inconsistency between calculations concerning heat content changes in the 0-1000m layer and conclusions on upper (0-50m) ocean temperatures changes. This is probably true south of 25°N as most of the changes occur in the upper layer, although those associated with changes in the Gulf of Mexico are not taken into account. But it is not so clear north of 25°N. A clarification of this point is thus necessary before publication.

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## Specific comments

Title : Impact . . . on what ? The title could be more precise

Abstract : I'm not convinced that the result presented in the last sentence of the abstract is a result of the analysis presented in this paper.

Section 3, last paragraph: You claim that you examine the vertical structure of the change in heat content but you only focus on near surface changes. North of 25°N, large changes occur down to 1000 m depth and even below. For instance, in the 400-1200m layer, the cooling north of 25°N increases with time but you do not comment it at all. On the contrary, south of 25°N, changes below 200m are small especially in JJA 2010, but still non negligible. There is certainly something to comment about those changes at depth, especially because they significantly contribute to the observed heat content changes.

It is not clear for me why it is expected that wintertime cooling and warming are smaller in magnitude (and smaller than what by the way?).

A title like "heat content changes" is probably more consistent with the content of the section than "impact of the slowdown".

Section 4: This section needs to be clarified. Is the first sentence of this section really true? Changes in ocean heat content are always considered as a result from a balance between air-sea heat exchange and heat transport divergence, as it is mentioned in the last paragraph of this section. By the way, how do you reconcile Taws et al 2011 results with yours?

1st paragraph: why do you consider a different reference period for the air-sea fluxes (1999-2008) and for the AMOC component (2004-2008)? What is the impact of the reference period on your results?

You say: "Hence we conclude that the cold upper ocean temperatures over the northern subtropics north of 25°N in winter 2009–2010 are primarily due to the slowdown

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in the AMOC and not to air–sea fluxes associated with the negative NAO conditions." What do you mean by "upper ocean temperatures"? Temperature in the 0-50m layer or in the 0-1000m layer? You clearly demonstrate that air-sea heat fluxes cannot explain the heat content changes estimated over a 0-1000m layer but does this demonstrate that air-sea heat fluxes cannot explain the upper (0-50m) ocean temperatures changes? Indeed, part of the heat content changes north of 25°N are due to temperature changes below 400m (see section 3). Similarly, how do you demonstrate that in winter 2010-2011, cold surface temperatures north of 25°N are due to the continuing effects of the slowdown in the AMOC?

Line 5 p 796: I don't understand your point in the sentence about the lack of data in the Gulf of Mexico.

I suggest to move the paragraph dedicated to the temperature anomaly pattern to Section 3 because, as it is, I don't understand why it appears in this section.

Finally, the last paragraph is a kind of justification of the approach but I'm not sure the discussion about ocean states estimates is relevant here.

Technical corrections Line 12: "Rapid observations" have not been defined. Section 3: "Heat content" should be "heat content anomaly" in most part of the text. Figures 1 and 2: For those who are not so familiar with all publications related to the Rapid project, I suggest adding, as on Fig 1 of McCarthy et al 2012, the mean values of each component, which will help understand how the 2009-2010 slowdown event has been defined and how the start, strength and duration of the slowdown can be computed. To ease the understanding, I also suggest consistent labeling and colors for each AMOC component on Fig 1 and 2. You could also add vertical bars to mark the beginning of the slowdown (January 2009), date when the AMOC reach its minimum (1.1 year after January 2009) and the end of the event (June 2010), or at least add a grid on your plots.

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