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Interactive comment on "Changes in extreme regional sea surface height due to an abrupt weakening of the Atlantic MOC" *by* S.-E. Brunnabend et al.

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We thank Referee 2 for the useful comments on the manuscript and our responses to the issues mentioned are given below (original comments are in italic).

1. How representative is the coastal sea-level in these simulations? Firing and Merrifield focus on a mid-ocean island. As we know the open ocean is eddy filled. However, eddies cannot be sustained near the boundary of the ocean e.g. Kanzow et al. J. Phys. Oc., 2009. Can you show that eddies have an impact on the real coastal sea- level i.e. are you sure that the eddy influence on the SSH doesn't diminish at the coast? Can the coastal sea-level derived from the model be validated against tide gauges (if not in

absolute terms, then in terms of the timescales of variability seen)?

We agree that eddies cannot be sustained near the boundary of the ocean and the sea surface height variability is strongly decreased on the boundary. However, disturbances still occur and Kanzow et al. (J. Phys. Oceanography, 2009) estimated a RMS sea surface height variability of 3.8-5.3 cm, depending on the time period investigated. In our study, the sea level extremes estimated near the coast of Lisbon and New York are within this range. The other two locations analyzed are at mid-ocean islands (Azores and Bermuda Island). We will add a short discussion regarding this issue in the revised manuscript.

In general, the simulation results of this study should not be compared to tide gauge records for several reasons:
- Tide gauges are measuring relative sea level change that does not only include changes in the ocean but also due to land movements, e.g. caused by land ice mass loss in other regions (e.g. in West Antarctica), GIA, earthquakes, land hydrology, or compaction of sediments. Also mass redistribution, caused by ice mass loss on land leads to a change of the geoid height and crustal deformation affecting the sea level regionally. The model simulation results do not have these signals included.
- The model simulations are forced with a climatological atmospheric dataset (CORE I; Large and Yeager, 2004) not including effects caused by temporal (non-seasonal) variations of the atmosphere.
- The global mean mass budget in the control simulation is set to zero by adjusting the precipitation fields.
- In order to strongly reduce to AMOC a huge amount of freshwater (0.1 Sv and 0.5 Sv) has been included as a hosing around the Greenland coast. These values are much higher than the ones currently estimated (around 200 Gt/yr   0.007 Sv). This is now mentioned in the revised manuscript.

2. In spite of this being a paper that studies the impact of an AMOC slowdown on sea-

level, there is little mention of the impact of mean circulation on sea-level. There has been a lot of work recently on sea-level rise along the US east coast being linked with the strength of the AMOC (e.g. Ezer et al., J. Geophys. Res. 2013). Could the authors look at the meridional changes in sea-level along the US east coast to see if they see similar changes to Yin et al., Nat. Geoscience, 2009?

We focus here on the influence of small-scale variations in sea level resolved by a high-resolution ocean model including its impacts on short-term extremes. However, the impact of mean circulation changes on sea level is important and a discussion on how the sea level is influenced by the mean circulation changes using different model resolutions is included in the revised manuscript and a comparison with the results in Yin et al. (2009) is given.

3. F2(bd): the coherence and strength of the GS as far south as the Florida Straits changes following the hosing experiment. I understand why the GS extension, north of Cape Hatteras, is affected by a hosing. But, when the GS is mainly wind driven in the Florida Straits, why would the circulation weaken there?

The strength of the modeled Gulf Stream is decreased near Florida Straits, as the hosing not only influences the ocean circulation in the North Atlantic, but also in the South Atlantic. The strength of the South Equatorial Current is slightly decreased and the strength of the Brazil Current is increased. The North Brazil current strength is reduced leading to a reduced strength of the Caribbean and Loop Current. For clarification, a short discussion has been added in the revised paper and the figure, showing the change in surface currents is extended to include also part of the South Atlantic.

4. Fig. 1. Missing data in the 0.1 Sv hosing HR experiment. Why are these data missing? Why wasn't a 0.1 Sv run done in LR? I think the reader deserves an explanation about this in the paper.

For the 0.1 Sv hosing experiment (high-resolution) some data loss was experienced as explained by Weijer et al. (2012, supplementary information). Quote: "The tempo-

rary storage system where the output was written out applies an aggressive scrubbing policy that removes files that have not been touched for a couple of weeks; failure to move the files to archival storage in time has resulted in some loss of data." (Weijer et al., 2012; doi: 10.1029/2012GL051611). Regarding the 0.1 Sv hosing experiment (low-resolution) an additional simulation was performed and the results will be included in the revised manuscript.

5. l134-150. As the GS has very stable separation latitude, I find this change very interesting. Could the authors comment more on why the hosing affects the latitude of separation? I think this warrants more discussion. I don't see why a simple weakening of the current would affect the latitude of separation.

Although the precise dynamical mechanisms are out of the scope of this paper, we will add a paragraph on possible mechanisms in the revised discussion.

6. Technical corrections
- All figures should have the font size increased
The font size of all figures has been increased.
- l56: Island -> Iceland
Corrected
- l13: could you use a more updated reference than Bindoff et al., 2007?
The reference Church and White (2011) has been added.
- l32-27: need a reference here that focuses on linking AMOC and sea-level. Srokosz et al. only summarise.
The reference Yin et al. (2009) has been added.
- l146: lateral density gradient: is this simply that the freshening to the north reduces the dynamic height difference across the GS?
Yes; the sentence has been extended to make it clearer.
- Fig. 7: the sea level rise figures should have the same y-axis for comparison. The very strong sea-level rise on the North American coast is somewhat less obvious when the axes are as they are.

These figures have been removed as part of the reconstruction of the manuscript. - *l178: a -> an*
Corrected
- Fig. 2 should be combined onto a single page and the font size increased, as it is difficult to read as it stands.
The old Figure 2 was combined with the old Figure 5 in the revised manuscript. It will now be on (as Figure 10) a single page and the font size will be increased.
- l276: sensitivity to freshwater perturbations is not discussed by Smeed et alâĂŤthey report a decline. Robson et al., 2014, Nat. Geoscience does link the current decline in the AMOC with high latitude density changes.
The reference to Robson et al. (2014) is included.
Fig. 10. typo in titles: detredet -> detrended
Corrected

Interactive comment on Ocean Sci. Discuss., 11, 1213, 2014.