The flow field of the upper hypoxic eastern tropical North Atlantic oxygen minimum zone

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Reply to reviewer #1

Reviewer #1:

This manuscript describes the horizontal circulation in the eastern tropical North Atlantic, focusing on the upper (300-400 m) oxygen minimum zone region south of the Cape Verde islands. The analysis uses a unique collection of observations from CTD, oxygen, and ADCP measurements during several cruises, profiling floats equipped with oxygen sensors, a tracer release experiment, as well as satellite data and an ocean reanalysis. This is an important set of results, particularly the combined view of the circulation from floats, ADCP measurements, and tracer concentrations. I recommend publication, but have several comments for the authors to consider first.

Answer to reviewer 1:

We thank both reviewers for the helpful comments, which helped to improve the manuscript during the revision. We modified the manuscript as explained below in the detailed comments.

Reviewer #1:

At the end of the Introduction, it would be helpful to have a couple of sentences summarizing what is new about this study. There have been many cruises along 23W that have measured currents and oxygen concentration, but presumably this is the first, or most comprehensive, to describe the two-dimensional circulation at the depth of the oxygen minimum zone from direct measurements. Also, the last paragraph of the Introduction is very long and difficult to follow, so I recommend splitting up into two sentences.

Answer to reviewer 1:

"While previous studies focused on the 23°W section or on hydrographic and current meter measurements from single cruises, here we combine different measurements particularly including float and tracer measurements to investigate the flow field and oxygen distribution of the OMZ in the ETNA varying on intraseasonal and seasonal time scales" and we include this information now at the end of the introduction. The last paragraph was split into two sentences as proposed.

Reviewer #1:

In section 4, it would be helpful to know what the key new/different results are. Which of your results confirm previous estimates of the circulation from other observations or models, and which are different from other studies? Also, what additional measurements would be helpful (or are planned) to further define the three-dimensional flow field as it relates to the OMZ?

Answer to reviewer 1:

We added some references to earlier papers and discuss the measurements needed to better define the three-dimensional flow field:

"While the floats and tracer spreading results are valid to better understand the circulation on a density or depth surface, the mean three-dimensional flow field can only be derived by averaging repeated hydrographic sections and thus removing the variability present in snapshots of the flow field from single ship surveys."

Reviewer #1:

Figures 10 and 11 have a lot of useful information, but can be difficult to interpret because of the noisiness of the velocity field and the Lagrangian nature of the measurements. I recommend adding one or two large, bold schematic arrows to indicate the main flow features that are discussed in the text (NECC, its recirculation north and south, Guinea Dome). You could also consider plotting the float trajectories in a separate panel since they can be difficult to see behind the ADCP vectors.

Answer to reviewer 1:

In figure 8 the float paths of the floats are plotted, however it is not possible to compare it with the related velocity and tracer signals in figures 10 and 11. Hence we tried to make the float trajectories better visible in figures 10 and 11. We use now similar colors for the floats as in figure 8 and the flow paths are much better visible in figures 10 and 11. As proposed some arrows are added to figures 10 and 11 to indicate the main flow features as proposed.

Reviewer #1:

It's difficult to see the direction of the circulation in figure 2 because the arrow are so small. I recommend using larger arrowheads with fewer and larger arrows.

Answer to reviewer 1:

We use now larger arrowheads. As the current bands have a small horizontal extension, we did not reduce the amount of arrows. However with the larger arrowheads and a larger figure (1-column width) the circulation in figure 2 should be well visible.

Reviewer #1:

p. 2162, line 14: "During the preconditioning phase of an AMM..." Do you mean ’negative AMM’?

Answer to reviewer 1:

The AMM is defined by an anomalous meridional gradient of sea surface temperature (SST) between the tropical North and South Atlantic. According to Figure 1c of Foltz et al. (2012) the SST gradient was lower than the mean SST gradient of the period 1982 to 2009 for both years 2008 and 2009 with a strengthening of the AMM mode in 2009 but no change of the AMM. As we describe only the region of the Guinea Dome following the description of Doi et al. (2010), we prefer not to discuss the entire AMM distribution of the tropical Atlantic however now we include the definition of the AMM in the revised text.

Reviewer #1:

It’s difficult to see the white ’x’ in figure 1 and the black ’x’ in figure 10. Maybe put circles around them to make them stand out more. Same for figure 11.

Answer to reviewer 1:

In Figure 1 the white ‘x’ is now covered with a black frame which makes the ‘x’ much better visible. In figure 10 and 11 (and also in Figure S5) the black ‘x’ is covered by a white frame and accents the ‘x’ from the current arrows.