

Interactive comment on “Cold vs. warm water route – sources for the upper limb of the AMOC revisited in a high-resolution ocean model” by Siren Rühls et al.

Anonymous Referee #2

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In this study the authors outline very clearly a compelling Lagrangian analysis of the different sources of water to the NBC, and how their respective property changes are brought about through the South Atlantic. I recommend this study for publication in Ocean Science, though as described below, I think that improvements could be made to the manuscript with the inclusion of more discussion on the big picture implications of their findings.

Main comments:

Two of the big picture implications that I think would be particularly valuable to discuss are: 1) the potential implications of the different routes for Stommel's advective salt

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feedback (or Fov; e.g. Drijfhout et al., 2011, Climate Dynamics). Models often get this wrong, and the implications for this may be large (e.g. Liu et al., 2017, Science Advances). I wonder, therefore whether, the models could be getting the Fov sign wrong because they are underestimating the fresher DP contribution. 2) A comparison of the pathways to those produced in more idealized and theoretical studies, such as the recent papers by Spencer Jones and Paola Cessi. This would be useful since those simpler models are the ones we often rely on for clearer diagnoses of the mechanisms at play.

It would also be useful to have more description of the study by Rodrigues et al., (2010), the observations of which are used to validate this work. The authors outline in the introduction that the relative contributions from each source are strongly debated between many studies. Therefore, in order for the reader to accept this study as the most accurate among them, it will require that we agree the comparison to observations is better. However, I only found a three-line description of that observational study (P9L31-25).

Finally, it would help if the authors could provide more discussion of the perceived weaknesses of the experimental setup. While many of the earlier studies did not use high resolution models, this model has quite a short spin-up time and appears to only use interannual forcing fields. E.g. might higher resolution winds allow more water to cross from the AC?

Other comments:

- P12L21: This is an interesting argument, and the authors have convincingly demonstrated that the two water masses are made more distinct by their salinity characteristics. However, what I think is probably more important in terms of how they should be labelled is the relative impacts the T and S differences have on density. While the water masses might be more easily delineated by salinity, it does not mean that those salinity differences have as big an impact on density as the temperature differences

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(e.g. if the salinity range is smaller). Given the nonlinearity of the equation of state, it may not be trivial to fully estimate those impacts, but a rule-of-thumb estimation would still be useful. If it turns out that the temperature differences have a larger impact on density, then the warm- and cold-route terminology would likely remain preferable.

- P13L1-5: I am unclear on these density definitions. Wouldn't these density definitions of surface, central and intermediate waters depend on latitude, and therefore be different for the two sources of water? Some additional description may help.

- P14L14-17: This is an interesting result and a very nice analysis.

- P15L32: I don't understand this first sentence.

- P16L14: The wording of this sentence could do with some revision.

- P16L27: Here and elsewhere, "evoked" should be something more like 'induced'.

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