

We would like to thank Reviewer 1 who provided constructive comments. Reviewer 1's comments have been reproduced in black with the authors' response in blue and excerpts from the revised manuscript in italics.

**First review of “New insights into the eastern Subpolar North Atlantic meridional overturning circulation from OVIDE” by Mercier et al.**

This study is comprised of a comparison of the AMOC from Greenland to Portugal between four different “data-driven” products, ground-truthed against the long-running hydrographic section OVIDE. The authors present an interesting decomposition of AMOC variability into volume-driven and velocity-driven variability and analyze this decomposition on both seasonal and decadal time scales. They find that seasonal AMOC variability along this line is dominated by volume variability (i.e. changes in the depth of the isopycnal of maximum overturning), while decadal changes are mostly driven by velocity variability.

The manuscript is well-organized, clear, and the results are interesting and timely. The referencing and placement into the larger scientific context are appropriate. I recommend that it be accepted for publication after minor revisions, which are mainly targeted at improving the presentation of the results.

Thank you for these positive comments.

Minor comments:

L18: The authors should consider explicitly mentioning the isopycnal of maximum overturning in the abstract. It is not immediately clear to the reader who is not yet familiar with the formalism that changes in volume are due to changes in the depth of the isopycnal of maximum overturning.

Certainly. We have added the following sentence : “*We decompose the MOC strength variability into a velocity-driven component due to circulation changes and a volume-driven component due to changes in the depth of the overturning maximum isopycnal.*”

L60: Recommend adding “with” after the comma.

Done, thank you.

L75: (Figure 1 caption) Consider adding the time period over which AVISO is averaged.

Done. The sentence in the caption now reads : “*OVIDE and OSNAP-East lines plotted over the mean over 1993–2012 of the AVISO surface dynamic topography (Jousset et al., 2022).*” We also added the reference of the dataset, which was missing.

L118: Missing “depth” at the end of the line.

“depth” has been added, thank you.

L139: The extracted dataset should be made publicly available and the citation provided in the

data availability section.

We now provide a netcdf file of the time series in the Supplement.

L147: Typo in GloSea. Recommend rewriting “in perspective with...”

The typo has been corrected and the sentence simplified. The text now reads: “*The reader is referred to Jackson et al. (2016; 2019) for a discussion of North Atlantic circulation features derived from GloSea5 reanalysis and ECCO state estimate and their comparison with other analyses.*”

L166: It would be helpful to explicitly refer to the publication that details the OVIDE inverse method formalism.

Done. We have included a new sentence before the inverse model description that reads : “*The inverse model was described by Lherminier et al. (2007); the main steps of the method can be summarized as follows.*”

L173: Section title and beyond: Should this be “MOC” rather than “AMOC” as it is referring to overturning strength at one latitude (expectation from L43). In general AMOC and MOC are used somewhat interchangeably in the main body of the text after a specific expectation is set up in the Introduction.

You are right. We have replaced “AMOC” by MOC where appropriate.

L181: referred → referenced

Done.

L236: Recommend removing “in this case” and specifying that this calculation is for the cross-correlations.

Done. We deleted “in this case” and added “*for the cross-correlation  $r$* ”.

L257: Please elaborate on the standard error calculation for the seasonal cycle.

Done. The sentence now reads “*The standard error was calculated as the ratio of the intra-annual standard deviation divided by the number of degrees of freedom on the assumption that MOC observations for a given month one year apart are independent.*” This standard error is now reported in section 4.3.

L285: (Figure 2) Can the authors make the y axis for ECCO the same as the others so that they are easier to compare?

Done.

L387: Unclear what is meant by “As in the first order”.

We replace “As in first order” with “*As in first approximation*”.

L400: (Figure 7) It is difficult to distinguish the cyan and blue lines. This comments also applies to Figures 8 and 10.

We replaced the cyan lines with ice blue lines to increase the contrast with dark blue lines.

L405: (Figure 8) Can you explain why there is a significant contribution from the eastern boundary current in Figure 8f but this is only apparent in GloSea5 in Figure 3?

Figure 8f shows the difference between autumn and summer. The eastern boundary current has a strong seasonality and is intensified in autumn compared to other seasons, hence the difference shows an eastern boundary intensification. Figure 3 shows the circulation in June-July and reveals that GloSea5 has a stronger eastern boundary current than the other analyses for this time period. To clarify this point for the reader, we have added the following comment: “*Note that although the eastern boundary current in GloSea5 was more intense in June–July than in the other analyses (Figure 3), the amplitude of its seasonality between July–August and October–November is similar to that of the other analyses.*”

L459: This is the first mention of the ASTE product (it may be left over from a previous version and should be removed).

Removed.

L460: Recommend starting a new sentence after ECCO. Suggestion for starting the next sentence: “At the same time, ECCO is the only...”

Done. Thank you.

L462: Please elaborate on/clarify the differences between how OVIDE and OSNAP handle the net transport across the line.

The point is that we determine the MOC strength by integrating the meridional overturning stream function from the surface and not from the bottom. We added a clarification: “*The net northward transport must be added to OSNAP MOC lower limb transport as it is included in MOC strengths determined by integrating the meridional overturning stream functions from the surface, as we do here.*”

L470: Recommend removing “Thus,”

Done. Thank you.

L500: “Noteworthy” is unclear here, could be replaced with “We find that” or “A new and noteworthy result is that”

Done, replaced by: “*A noteworthy result is that ...*”. Thank you.

L526: It is potentially also worth discussing the connection to seasonal density variations in the EGC in the context of the comparison with Li et al. 2019, not just decadal.

This point is addressed in the text from the work of Fu et al. (2023) who analyzed a longer OSNAP time series than Li et al. (2019) but, you are right, we can also cite Li et al. (2019), which we were happy to do.

L534: de Jong and de Steur (2016) should also be discussed in the context of Irminger Sea convection (or at least referenced in conjunction with Irminger Sea convection somewhere). de Jong, M. F., and L. de Steur (2016), Strong winter cooling over the Irminger Sea in winter

2014–2015, exceptional deep convection, and the emergence of anomalously low SST, *Geophys. Res. Lett.*, 43, 7106–7113, doi:[10.1002/2016GL069596](https://doi.org/10.1002/2016GL069596).

Certainly. We now make reference to de Jong and de Steur (2016). The sentence now reads : “*The North Atlantic Oscillation (NAO see Hurrell, 1995) is known to be the driver of density field changes in deep convection zones in the Labrador and Irminger Seas (Yashyaev et al., 2016; Piron et al., 2017; de Jong and de Steur, 2016).*” Note that de Jong et al. (2018) was already referred to in the introduction.

L541: It looks like the total overturning variability is also positively correlated with the NAO, not just the components. Could the authors please discuss whether this is the case?

This is the case, in agreement with the fact that on a decadal scale, the variability of the strength of the MOC mainly follows that of  $\psi'_v$ . We have added the following sentence: “*The MOC strength is positively correlated with NAO ( $r=0.50$ ;  $p=0.38$ ), which is consistent with the fact that, on longer time scales, the variability of the MOC strength is mainly driven by  $\psi'_v$ .*”