

Reply referee 2

We would like to thank the reviewer for his/her review and constructive feedback. We appreciate the effort and time the reviewer has invested in evaluating our work. Please find our point-to-point response below in blue.

The manuscript entitled “Mesoscale Dynamics and Transport in the North Brazil Current as revealed by the EUREC4A-OA experiment” by Barabinot et al. uses a series of in situ observations (CTD, uCTD, ADCP, MVP, Argo floats) and satellite measurements to characterize the 3-D structure of surface and subsurface North Brazil Current rings (size, Rossby number, depth, T-S properties) and estimate the associated mass and heat transport that plays an important role in the interhemispheric water exchange and, consequently, to the AMOC. The manuscript is very well written and exposed logically; the results are clear and important, particularly when it comes to quantifying subsurface eddy transport once these eddies are not detectable from altimetry. Also, the authors have done a great job with the literature review and putting their results into context by comparing them with previous studies. I am suggesting some (minor) additional work to improve the clarity of the manuscript. Thus, I recommend the publication of this manuscript after minor revisions.

I suggest adding a figure (Figure 1) of the region of interest with some of the key currents and the NBC rings for broader context (either a schematic or satellite ADT map). This will help the readers to (1) visualize the region of interest and the dynamics associated and (2) put your results into a broader context in terms of interhemispheric water exchange and link to the AMOC.

We thank the reviewer for his/her relevant suggestion. We agree that including a figure of the study region with the major currents would enhance the clarity of the manuscript. Accordingly, we have added such a figure in the revised version.

I. 1. NBC rings are not a mechanism but features. I suggest writing ‘The North Brazil Current (NBC) rings are key features...’.

We thank the reviewer for bringing this to our attention. We agree and have corrected the wording in the revised version of the manuscript.

I.2. Better written as ‘...South Atlantic and North Atlantic Ocean’.

We thank the reviewer for bringing this to our attention. The sentence has been corrected in the revised version of the manuscript.

I.3. Water masses are associated with T-S properties, so to me, the ‘properties of water masses’ doesn’t make much sense. I suggest writing ‘...by these structures and the water masses they advect.’

We thank the reviewer for bringing this to our attention. The sentence has been corrected in the revised version of the manuscript.

I. 10 is a bit confusing. Suggestion: 'We estimate that the heat transport by surface and subsurface NBC rings is 5.8 TW and 0.3 TW, respectively, which is significantly lower than previous findings.'

We thank the reviewer for bringing this to our attention. In the revised manuscript, we have replaced our original sentence with the reviewer's suggested wording.

I. 12. And -> to? 'for South Atlantic Waters across the equator to the Tropical North Atlantic.'

We thank the reviewer for his/her suggestion. In the revised manuscript, we have replaced our original sentence with the reviewer's suggested wording.

*I. 16-19. 'This retroflection' -> it is not clear that there is a retroflection based on the first line. Also, NBC rings are *formed* by NBC shedding; they do not shed *into* NBC. I suggest rewriting the first paragraph. Adding Figure 1 (broad scope) would help as well.*

We thank the reviewer for bringing this to our attention. In the revised version, we have rewritten the paragraph following the reviewer's suggestion. The addition of Figure 1 will help clarify the context.

I. 73. 'Further research is needed...' this sentence makes it sound that the current manuscript doesn't cover this, which is not the case. I suggest rephrasing to indicate that it's a gap and/or that you are addressing this in the current manuscript.

We thank the reviewer for his/her suggestion. In the revised manuscript, we have replaced our original sentence with the reviewer's suggested wording.

I. 81. Typo in the L'Hegaret et al. 2020 citation.

We thank the reviewer for bringing this to our attention. The typographical error has been corrected accordingly in the revised manuscript.

I. 122 and I. 131. Add somewhere in this section that the first baroclinic Rossby radius of deformation in the equatorial region is $\sim >150$ km, which means that the horizontal resolution of the instruments is high enough to resolve mesoscale eddies/NBC rings (assuming you need 4 to 6 grid points to solve a feature).

We thank the reviewer for his/her relevant suggestion. Following Chelton et al. (1998), we have added the order of magnitude of the baroclinic Rossby radius of deformation in the revised manuscript.

I. 137. Make it clear that the changes in sign of the velocity happen in the horizontal direction

We thank the reviewer for his/her comment. We have clarified the sentence in the revised manuscript.

I. 220. Across -> along depth

We thank the reviewer for bringing this to our attention. We have corrected the wording in the revised version of the manuscript.

I. 225 Typo. Remove 'used'.

We thank the reviewer for bringing this to our attention. The typographical error has been corrected accordingly in the revised manuscript.

I. 228. I suggest adding at the end: '..., as well as the depth variation in the eddy radius.'

We thank the reviewer for his/her relevant suggestion. The suggestion has been added in the revised version of the manuscript.

I. 233. Seawater specific heat capacity

We thank the reviewer for bringing this to our attention. The wording has been corrected in the revised manuscript.

I. 272. 'regarding that the' -> 'according to the'

We thank the reviewer for bringing this to our attention. The wording has been corrected in the revised version of the manuscript.

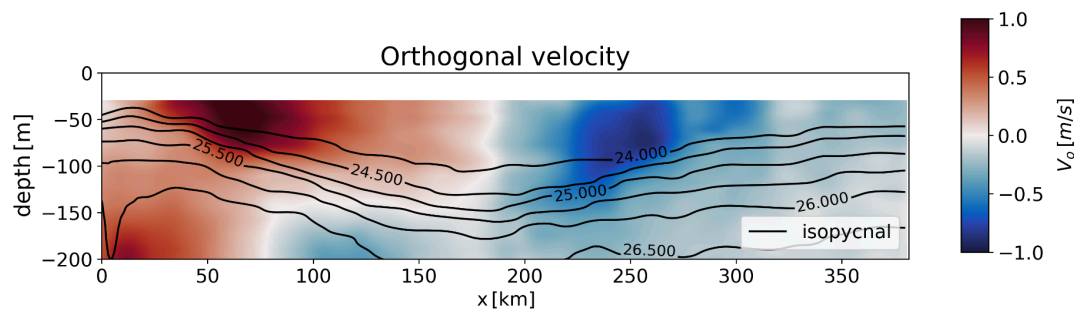
Figure 2 and Figure 4 are very nice!

We thank the reviewer for his/her comment.

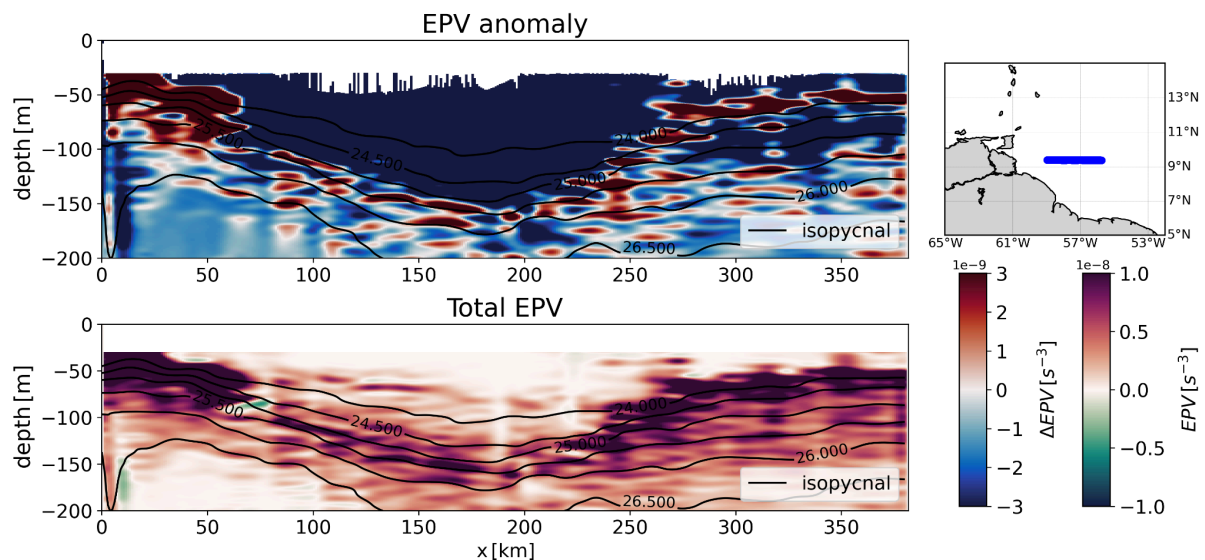
I. 299-300. What makes the authors believe that the surface and subsurface eddies are not part of the same eddy structure? Is the small tilting enough to claim that these are individual eddies? Just curious, but I think including this in the text is relevant.

We thank the reviewer for his/her relevant question. We agree that this is not an obvious statement; however, several arguments support the conclusion that the surface and subsurface eddies do not belong to the same eddy structure.

First, the velocity field and the stratification observed along cross section 5 of the RV Atalante indicate that the pycnocline (defined as the depth of the maximum Brunt Vaisala frequency) divides the vertical structure of the flow into two distinct layers, each with its own velocity maximum. The figure below provides a zoomed view of this vertical separation: the surface structure is visible from 0 to 300 km at depths shallower than -150 m depth, while the subsurface structure appears from 0 to 150 km at depths greater than -150 m. We observe that the positive velocity core of the surface structure lies directly above the negative velocity core of the subsurface structure.



Second, If we define eddies on their Ertel PV anomalies, the two structures exhibit distinct anomaly values and are separated by the pycnocline. The figure below shows the Ertel PV and its anomaly along cross-section 5 of the RV Atalante.



Third, using the criterion proposed by Barabinot et al. (2024) – namely, the ratio $\Delta EPV_z / EPV_x$ – to define the cores of NBC rings, we show that the surface and subsurface structures do not share the same core (see Figure 9 of the article).

This observation holds for the duration of the campaign, although the available data are insufficient to track the full life cycles of the two eddies. It remains possible that they were part of a single structure prior to the observations.

Figure 10. Great figure! Very instructive.

We thank the reviewer for his/her comment.

I. 333 typo ‘.’ After NBC_sub2

We thank the reviewer for bringing this to our attention. The typographical error has been corrected accordingly in the revised manuscript.

Figure 4. What is being called NBC_surf2 eddy is actually a recirculation feature. Although this feature shows as a closed SSH contour and would probably be detected in other eddy methods, this is not strictly speaking an eddy. It is just a recirculation within the retroflection (or an about-to-form eddy, but there it is still attached to the current, thus it will not drift away as an eddy would). I suggest discussing this.

We thank the reviewer for his/her relevant remark. This question also arose during the preparation of the manuscript. We considered the feature to be a vortex in the process of forming, but as its signature weakens over time, it is difficult to draw a definitive conclusion. We have added the discussion suggested by the reviewer in the revised manuscript.

I. 501 Typo. remove ‘only transport’.

We thank the reviewer for bringing this to our attention. The typographical error has been corrected accordingly in the revised manuscript.

I. 505 The large transport in the surface rings compared to the subsurface ones is due to the higher temperatures but also to the larger translation velocities associated with the surface eddies.

We thank the reviewer for bringing this to our attention. We have added this argument to support our conclusions.

I. 421 space missing between ‘km’ and ‘captures’.

We thank the reviewer for bringing this to our attention. The typographical error has been corrected accordingly in the revised manuscript.

References:

- Barabinot, Y., Speich, S., & Carton, X. (2024). Defining mesoscale eddies boundaries from in-situ data and a theoretical framework. *Journal of Geophysical Research: Oceans*, 129(2), e2023JC020422.
- Chelton, D. B., DeSzoek, R. A., Schlax, M. G., El Naggar, K., & Siwertz, N. (1998). Geographical variability of the first baroclinic Rossby radius of deformation. *Journal of Physical Oceanography*, 28(3), 433-460