Response to Reviewer 1:

Review of Dimoune et al.: “Revisiting the tropical Atlantic western boundary circulation from a 25-year time series of satellite altimetry data”

This study uses 25 years of satellite altimetry data to describe the mean surface circulation of the Western Tropical Atlantic. The authors describe in detail the seasonal cycle of different branches of the South Equatorial Current, the North Brazil Current and the Guyana Current at different zonal and meridional transects. A main novel result of this manuscript is the description of a current branch at 0-2◦N, above the Equatorial Undercurrent. This surface branch was previously unremarked in the literature and appears to be an extension of the North Brazil Current retroflection. Consistent with the literature, the results show that some of these branches have in-phase seasonal cycles, peaking in late winter/early spring, whereas others peak in fall. The interannual variability of the circulation is related to the Tropical Atlantic Meridional Mode. This is study is a relevant update of the mean and low-frequency variability of the surface circulation in a globally important region of the tropical ocean, where vigorous interhemispheric exchanges take place. The analysis is simple but robust and the manuscript is organized logically. I have to admit, however, that I had a hard time getting through the text, which is terse and acronym-laden. Besides addressing the technical points below, I strongly recommend the authors work on their text to make it accessible to those who do not work on the Tropical Atlantic oceanography every day.

Answer: First of all, we thank you for your review, comments and remarks that help to improve this work and make it clearest and the understandable possible.
We have carefully taken in consideration the comments and remarks. The complexity of the western boundary and the multiple currents that are involved, and which are studied here can make the text hard to be accessible. However, we have tried to make it more understandable by creating a table of acronyms to help the reader to rapidly refer to if necessary.

Specific and technical points:

1. Geostrophic currents near the Equator

The manuscript lacks a description of the robustness of the equatorial β−plane approximation for calculating geostrophic velocities at • }3◦ of the Equator. How accurate are these velocities? Can you really trust small changes in speed across the Equator (e.g., described in section 3)?

Answer: Thank you for your comments. Indeed, you are right. So, in the new version of the manuscript, we have given more details about the β−plane approximation. We have also looked for current meter and ADCP data to validate the geostrophic currents at the equator, and prove the existence of the equatorial eastward surface flow. We found at the PIRATA buoy location available in our study area (0°N35°W) current meter observations at 12-m depth, corresponding to a few months in our data time series (11/10/2017-29/01/2018: Figure 2 below) that we have used to validate the geostrophic currents in the equatorial region. We also looked for German cruises SADCP data (downloaded from the data center PANGEA https://doi.pangaea.de/10.1594/PANGAEA.937809 and described in Tuchen et al, 2022) and plotted the meridional sections of the currents at 40°W, 35°W and 32°W to show the existence of the equatorial surface eastward flow in the surface.

Here below are some analyses done:

The Comparison between the current components from the current meter at 12-m depth and the geostrophic currents (interpolated to the equator) over the period 11/10/2017-29/01/2018 (5 days means) shows as usual an underestimation of the latter (Picaut et al., 1989; Lagerloef et al., 1999, Pujol et al., 2016). The zonal components of the currents from both data show a correlation of 0.71 while the meridional ones are weaker (Figure 1a-b). The mean biases/standard deviation errors of both components are respectively 0.04 /0.11 m s^{-1} and 0.14/0.03 m s^{-1}. This result is consistent with Lagerloef et al. (1999) who found similar value in the western Pacific (0°N165°E and 0°N170°W). The authors have compared current mooring (10-m depth zonal component) to the zonal component of the geostrophic current at the equator and found correlations of ~0.70 and biases <0.1. Our results compared to the previous ones give then credit to the altimeter-derived geostrophic currents used in this study.

Looking forward to investigate the surface eastward currents the available data of the PIRATA current meter from November 2018 to 25/03/2019 show a surface eastward current at 12-m depth during the whole period (Figure 2). This confirms the previous findings of Bourlès et al. (1999b) and justify our investigation to know more about this surface current.

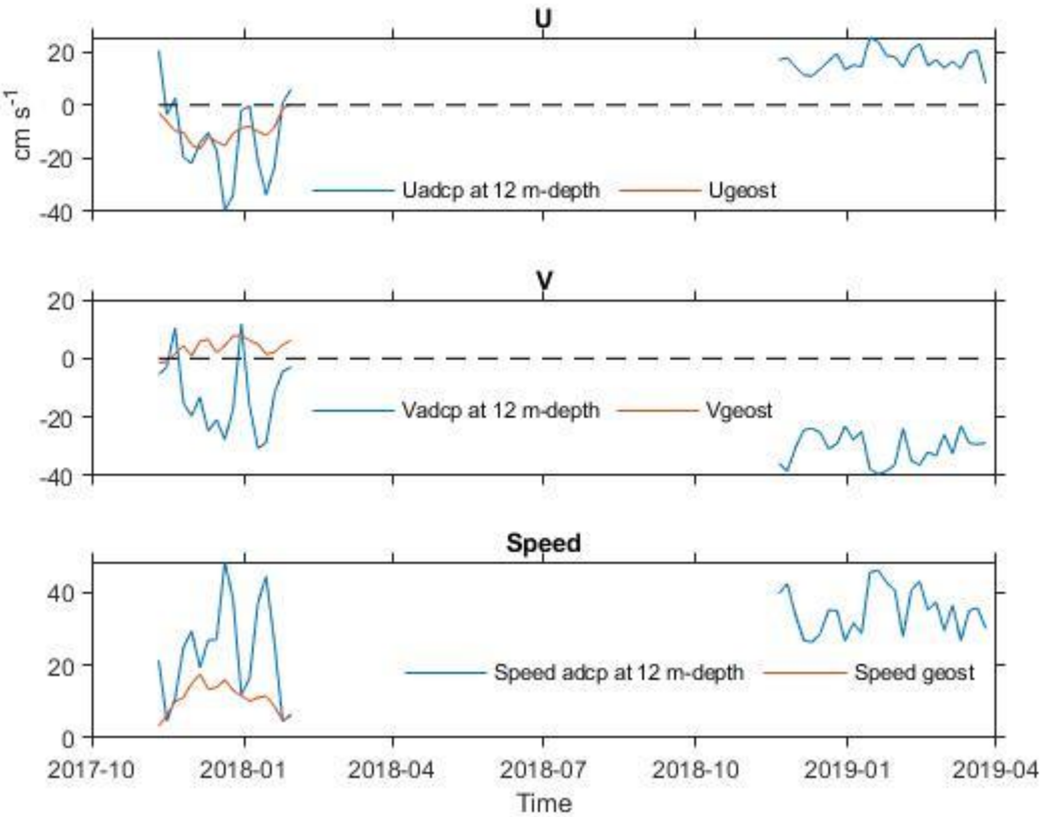


Figure 1: Time series of the PIRATA mooring current (12-m depth) and the altimetry geostrophic currents at 0°N35°W over 11/10/2017-25/03/2019 period. The top and middle panels represent the zonal and the meridional components of the currents, respectively, and the bottom panel represents the current speed. Note that the geostrophic currents were only available for 11/10/2017-29/01/2018 period.

We have also analyzed all the individual Shipboard ADCP sections from German cruises available in the study area (meridional sections at 40°W, 35°W and 32°W) to look for the presence of the equatorial surface eastward flow shown in our study. The first depth at the surface of each section varies from 0-m to 17-m depth depending on each cruise, and we have now taken them into account in the new version of the paper to argue about the presence of the surface eastward flow in our study area. Figures 2-10 below show both the zonal and meridional components of the currents (top and bottom panels, respectively). The dashed/solid contours represent the westward/eastward currents, and the contour intervals are each 0.2 m/s for both components U (zonal) and V (meridional).

The sections at 40°W during the first half of the year (Figures 2-3) clearly show the presence of an eastward flow in the upper layer between 0°-2°N as shown using the geostrophic currents. At 35°W, this flow is extended to 2°S, with usually a northward meridional component between 0°-2°N (Figures 4-7) in the first half of the year (March-June). This is consistent with the cyclonic circulation found using the geostrophic current in our study during boreal spring. In October-November (Figures 8-9), the equatorial surface eastward flow appears weaker and less extended (1°S-1°N) with a southward meridional component between 0°-1°N. This may explain why we didn't find any cyclonic circulation during the second part of the year. At 32°W (Figure 10), the unique section in June show a weaker surface flow in the upper layer shifted to the south between 2°S-0°N. This is also consistent with our findings.

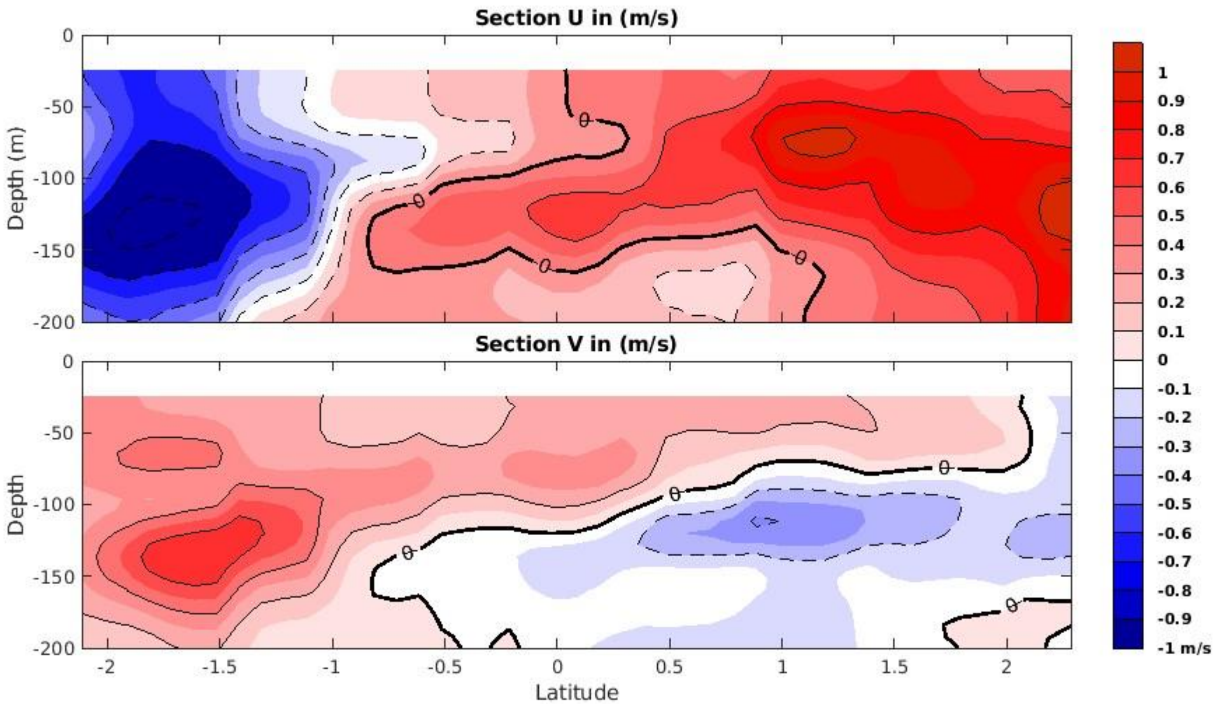


Figure 2: Shipboard ADCP section at 40°W between 2°S-2°N during 07/03/1994 to 10/03/1994 period.

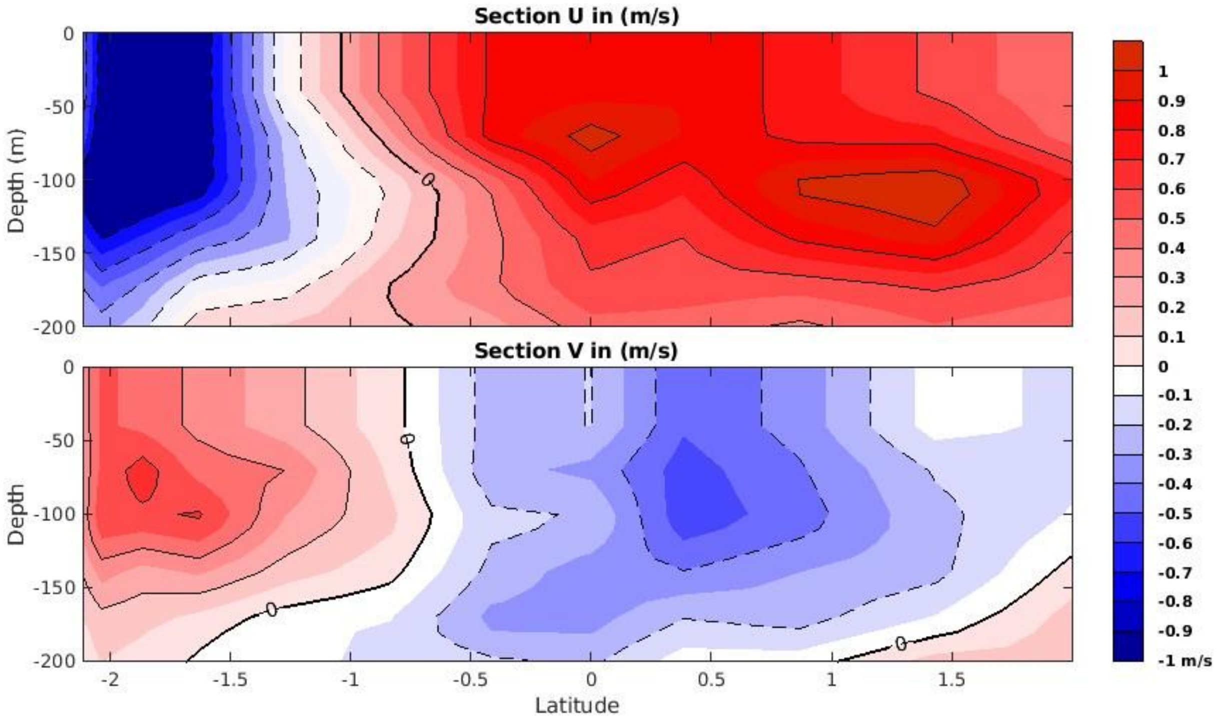


Figure 3: Shipboard ADCP section at 40°W between 2°S-2°N during 03/05/2003 to 05/05/2003 period.

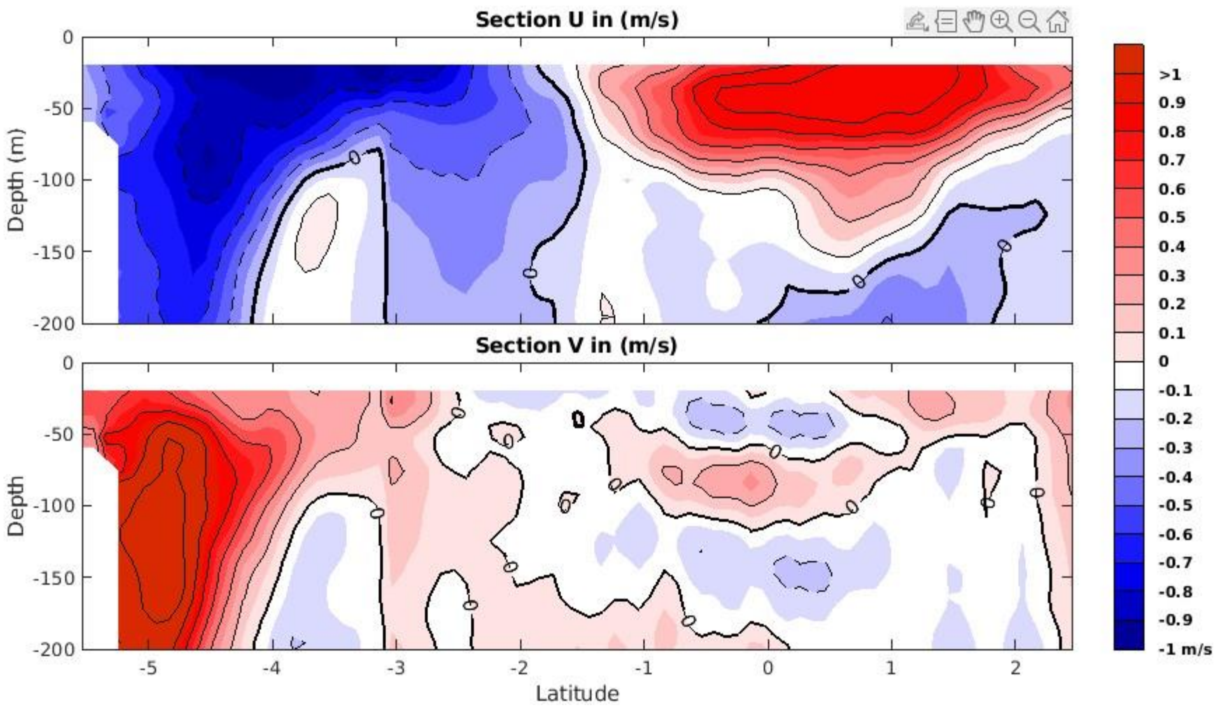


Figure 4: Shipboard ADCP section at 35°W between 6°S-3°N during 30/05/1991 to 05/06/1991 period.

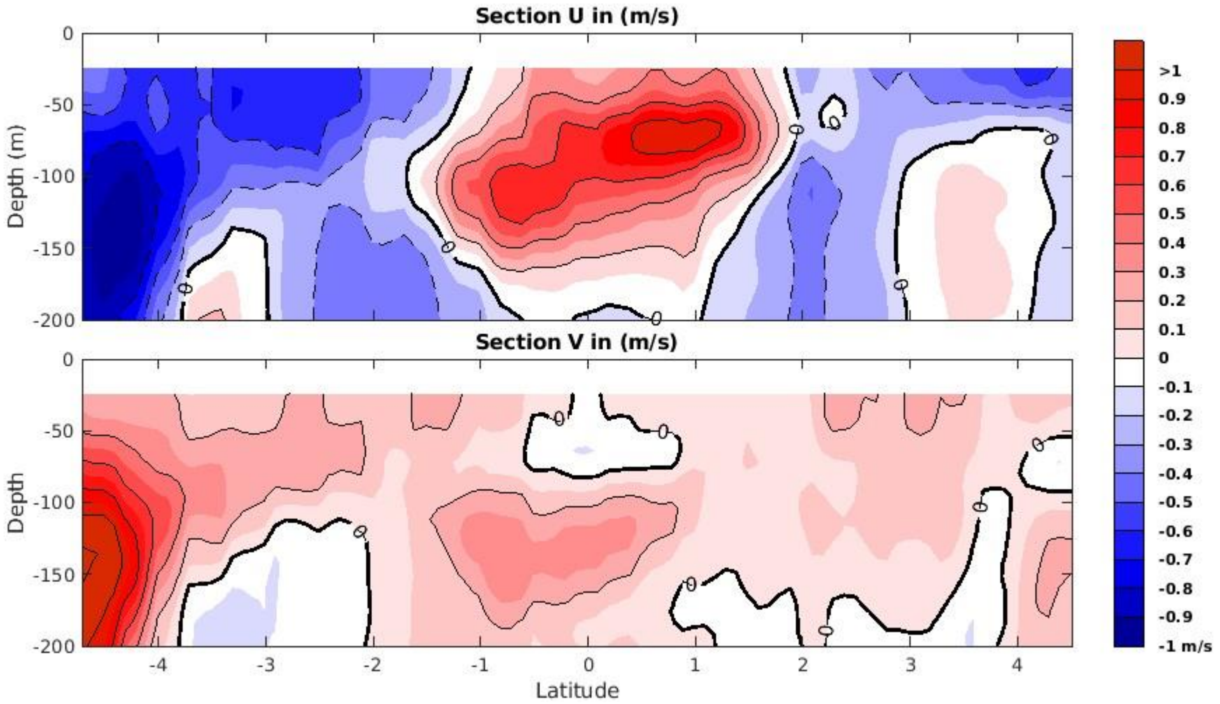


Figure 5: Shipboard ADCP section at 35°W between 5°S-5°N during 13/03/1994 to 18/03/1994 period.

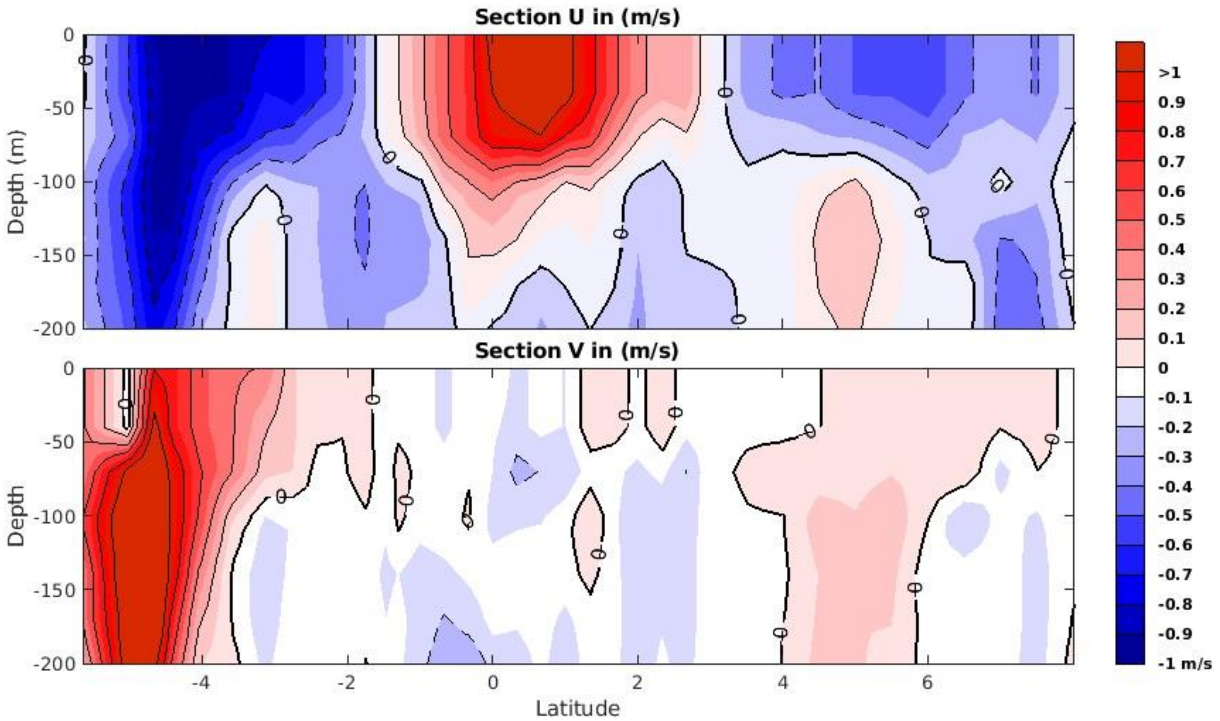


Figure 6: Shipboard ADCP section at 35°W between 6°S-8°N during 09/05/2002 to 16/05/2002 period.

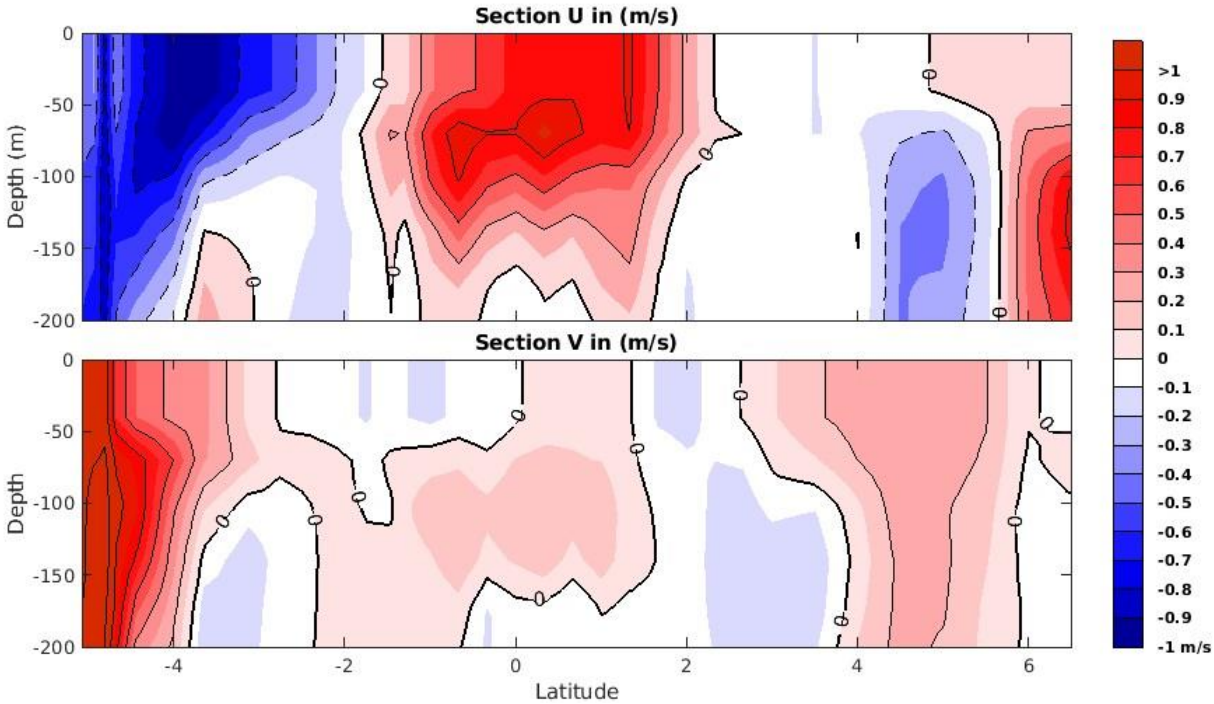


Figure 7: Shipboard ADCP section at 35°W between 5°S-3°N during 26/05/2006 to 01/06/2006 period.

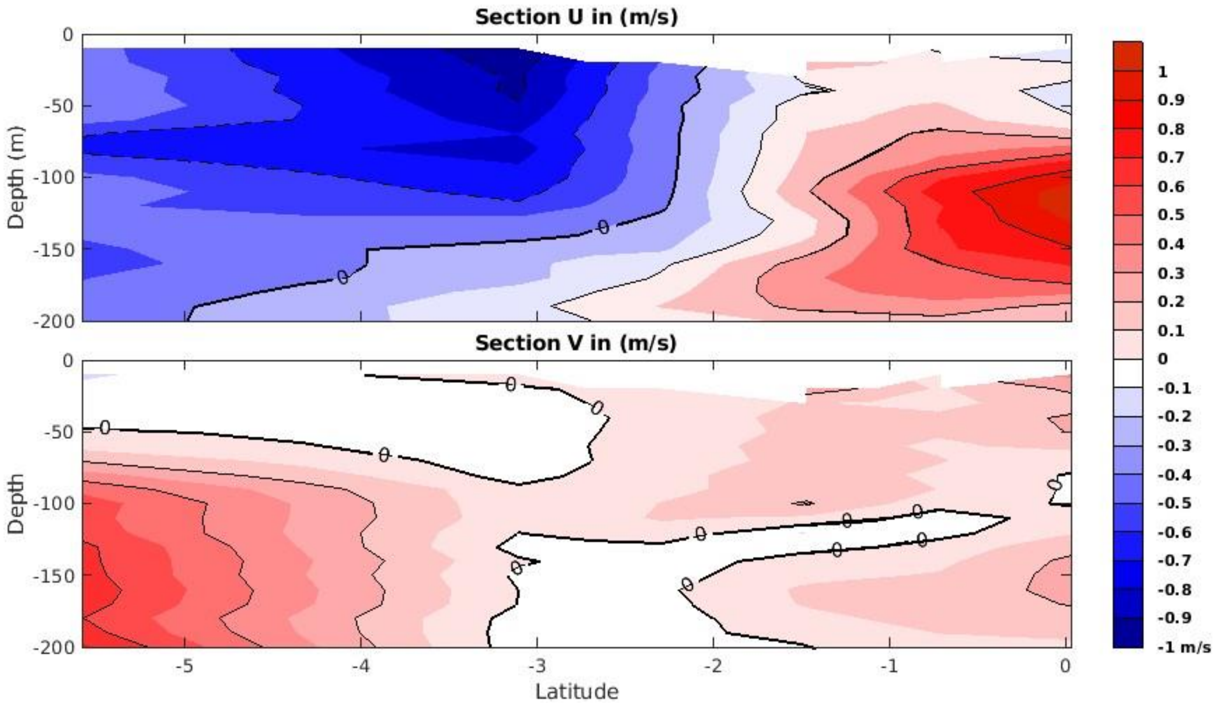


Figure 8: Shipboard ADCP section at 35°W between 6°S-0°N during 17/10/1990 to 22/10/1990 period.

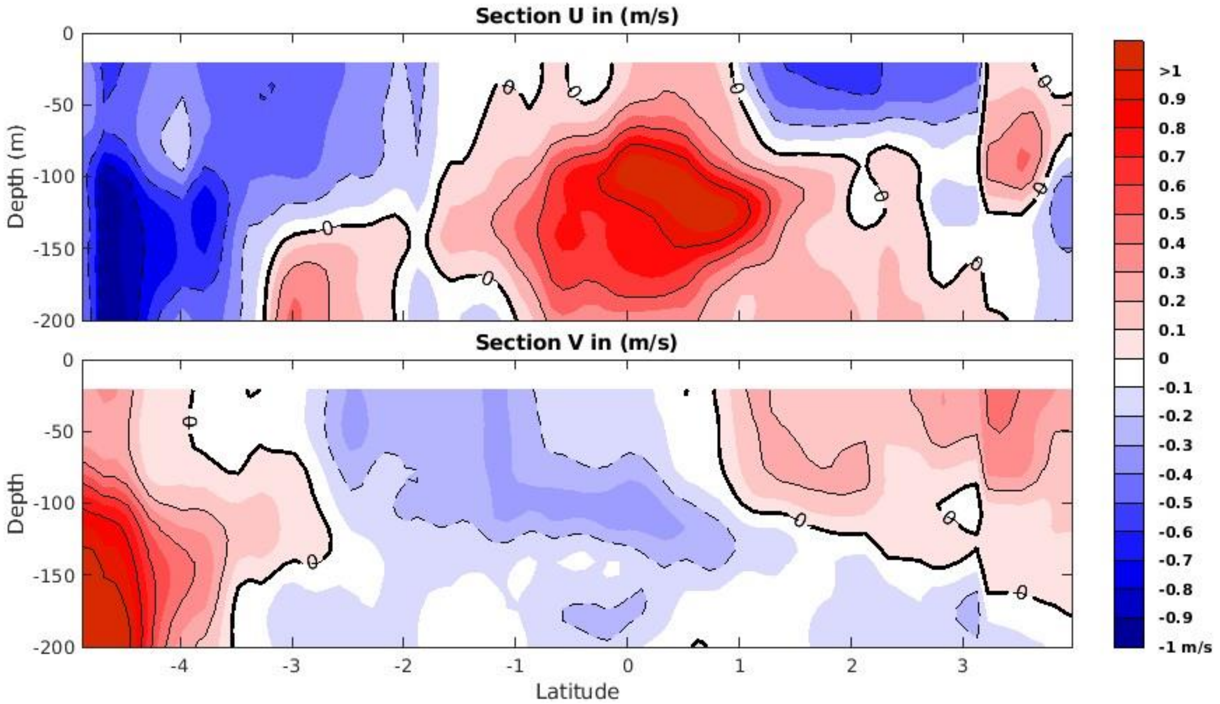


Figure 9: Shipboard ADCP section at 35°W between 5°S-4°N during 02/11/1992 to 07/11/1992 period.

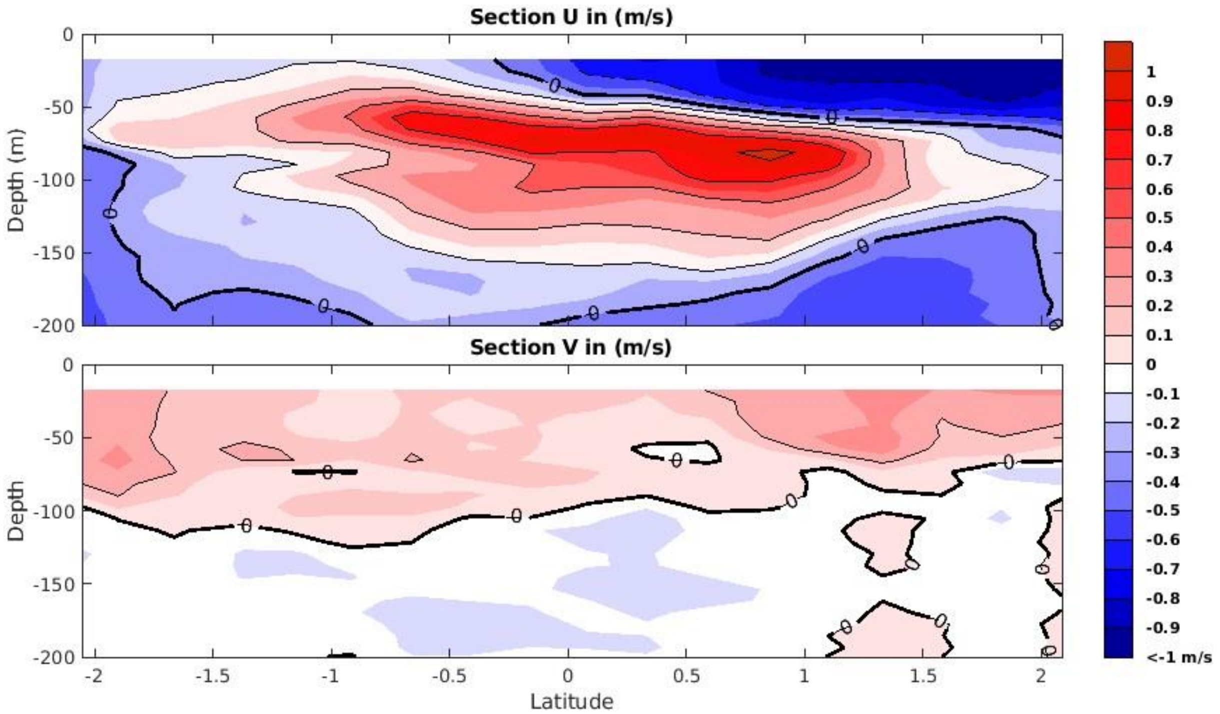


Figure 10: Shipboard ADCP section at 32°W between 2°S-2°N during 12/06/2006 to 13/06/2006 period.

Reference: Tuchen, F.P., P. Brandt, J.F. Lübbecke, et R. Hummels, Transports and Pathways of the Tropical AMOC Return Flow From Argo Data and Shipboard Velocity Measurements,

Journal of Geophysical Research: Oceans, 127 (2), e2021JC018115, https://doi.org/10.1029/2021JC018115, 2022

2. Intraseasonal variability

From figure 2, the intraseasonal/subsesonal variability (< 120 days) is as important as the seasonal variability. The authors should discuss the intraseasonal variability instead of the interannual variability.

Answer: Thank you for your suggestion. We have chosen to dedicated our study to the seasonal and interannual variability because recent studies have been already done concerning the intraseasonal variability with also products derived from altimetry and multi-observations products. However, as we mentioned at the end of the paper, our new challenge would be to find a coastal altimetry product that will allow a significantly better resolution and accuracy along the continental shelf to further explore this question.

3. Some methodological details are missing

The authors should improve their description of their estimation of various current properties. For example, how do the authors estimate these properties in table 1? Are the authors simply choosing are maximum velocity in the transect? How about the current width? Are the authors eye-balling this property from year transect? Wouldn't fitting a functions (e.g., a gaussian) to the cross-track velocity profile be a more effective way to estimate those properties? Also, does the interpolation of satellite altimetry sea-level from along-track to regular grid smear the currents? What's the effect of this interpolation on the width and intensity of the currents? Please, discuss.

Answer: Thank you for your suggestion. We have tried to give further description in the corrected manuscript in order to facilitate the reading.

Indeed, our approach to determine the current width was the simple one. The width of the currents is determined by the mean of the current over the whole period of study (1993-2017) at each grid point. Then, it is important to know the sign or direction of the current (eastward or westward) to be able to define the limits of the currents which are the location where the current is null. So, the distance between both limits is define as the width of the currents (See left boxes of each Hovmöller diagram in Fig. 3). However, to compute the strength of the currents, our approach was to consider the flow between the contour lines of half of the maximum speed (velocity) from either side, and average the values over time to obtain time series.

It has been reformulated in the revised manuscript as follows: "In order to further investigate the temporal variations of the current amplitude or strength, the maximum speed (velocity) values of each current paths have been determined for each month. These maxima correspond to the current core and are called Vmax hereafter (see Fig. 3, green line on S1), and their location corresponds to the location of the current core. Then, to estimate the current relative strength/intensity, we have considered part of the sections of velocities larger than Vmax/2 (see Fig. 3, blue lines on S1); and we finally computed the strength/intensity values by averaging all the velocity values of these parts over time. The width of the currents (Table 2) is determined by the mean of the current over the whole period of study (1993-2017) at each grid point (see left boxes of the Hovmöller diagrams of Fig. 3). Then, knowing the sign or direction of the current (eastward or westward), the corresponding time series are used to define the width by finding the limits where the current is null. Note that the current strength/intensity has also been computed by averaging velocity values over the entire width of the current paths (e.g., not only where the velocity is larger than Vmax/2), but the results did not correctly reflect the current variability observed in Fig. 3 and Fig. 4 (not shown).

For the NBCR and the NECC, the variability of the maximum speed (velocity) of apparently two flow/branches and their corresponding locations is also analyzed, in order to compare with the study of Fonseca et al. (2004). The goal is also to investigate the variability of the current location with respect to the wind variability and to the tropical Atlantic climate modes. In this study, the presence of apparently two flows of the NBCR and the NECC two-core structure are identified when the velocity profile of the currents shows two local maxima separated by a local minimum respectively, in the NBCR region (considered between 4°-10°N) and the NECC region (considered between 3°-11°N) (Fig. 4S4-S6)."

Concerning the interpolation, so far, the method used to produce the DUACS (Data Unification and Altimeter Combination System) products is the best compare to the other and is known to minimize the error effect on the derived data (Lagerloef et al., 1999; Dibarboure et al., 2011; Pujol et al., 2016).

New reference: Dibarboure, G., Boy, F., Desjonqueres, J. D., Labroue, S., Lasne, Y., Picot, N., Poisson, J. C., and Thibaut, P.: Investigat- ing Short-Wavelength Correlated Errors on Low-

Resolution Mode Altimetry, J. Atmos. Ocean. Technol., 31, 1337–1362, doi:10.1175/JTECH-D-13-00081.1, 2014.

4. Figures are difficult to read

Most figures are barely readable. The labels are tiny and oftentimes there are too many lines in the plots. The authors should increase the labels, rearrange the panels, and try to use less lines to improve readability.

Answer: Thank you for the suggestion. We have improved the figures. For the case of Fig. 4, we even removed the map at the left side, because the reader can refer to Fig. 1.
Here below is the new Fig. 4:

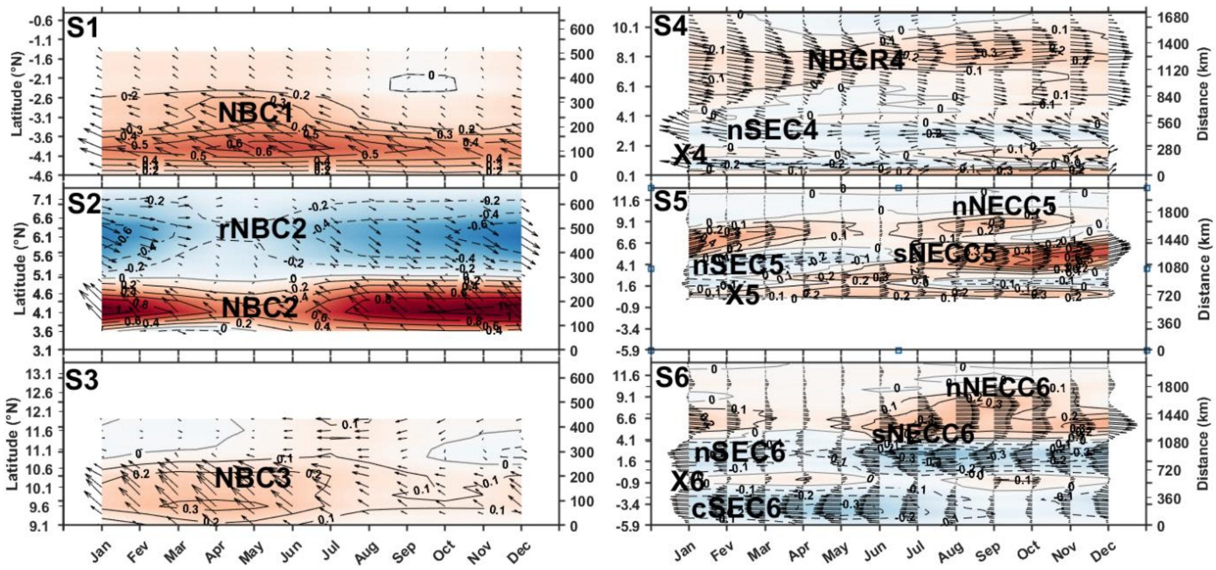


Figure 4. Average seasonal cycle obtained from Figure 3 (vectors of the currents are superimposed on the contour of their amplitude in m s^{-1}). On the right sides of each subplots, the distances from the southernmost point (in km) are indicated.

5. Tidal correction on the Amazon Shelf

I think the "erroneous altimetry measurements" mentioned around line 160 is actually poor tidal corrections on the Amazon Shelf. The authors should more clearly described what they consider unrealistic values. What criterion are the authors using to remove those values?

Answer: Thank you for the comment. Yes, we have made it clear in the corrected version of the manuscript. We have reformulated as follows: "Note that, data with higher variability (standard deviation > 0.4) have been removed. They are found in the Amazon region which is not a primary area of interest for this study, and where, the annual mean current speeds are unrealistic (higher than 2.5 m s^{-1}), probably due to geographically correlated errors (Pujol et al., 2016).

6. Wind-driven currents

As the name suggests, the GEKCO product contains both geostrophic and Ekman currents. If the authors are interested only in Ekman currents for figure 9, why don't the authors calculate those directly from ERA5?

Answer: Yes, you are right. In fact, the GEKCO Ekman currents were only used to evaluate the probable importance of the Ekman currents over the altimeter-derived geostrophic currents in the equatorial region. We chose to use them because they have been already validated in the equatorial region (Sudre et al., 2013), and we mentioned it to inform and notify the work that has been done.

As the goal of the paper was to evaluate the influence of the large-scale remote wind on the regional circulation, the use of ERA5 wind is justified. Also, these currents do not impact much the geostrophic currents west of 32°W. So, we decide to remove it in the final version of the manuscript to avoid confusions since the geostrophic currents are validated in the equatorial region.

Typing, English and minor technical corrections

1. line 43: change works with studies.

Answer: Thank you for your comment. It has been considered.

2. line 51: (...) North Brazil Under Currents (NBUC) which raises to the surface around → (...) North Brazil Under Currents (NBUC), which surfaces around.

Answer: Thank you for your comment. It has been considered.

3. line 77: meaning of "no more respected" is unclear. Do you mean "no longer satisfied"?

Answer: Thank you for your comment. Indeed, we wanted to say "no longer satisfied". The sentence has been reformulated.

4. line 92: Do you mean understudied?

Answer: Thank you for your comment. Indeed, we wanted to say understudied. It has been considered.

5. lines 108, 110 and elsewhere: "to allow" is a transitive verb—something or somebody allows somebody to do something else. So the dataset allows you to provide a more robust (...).

Answer: Thank you for so much for your comment. It has been considered.

6. line 111: as follow → as follows.

Answer: Thank you for your comment. It has been considered.

7. line 125: Why the hat in Goˆes?

Answer: Thank you for your comment. It was a mistake. It has been considered.

8. line 158: averaged on a monthly basis → averaged monthly.

Answer: Thank you for your comment. It was a mistake. It has been considered.

9. line 183 and elsewhere: Pound → Pond. (Also, those should be 10-m winds, right?)

Answer: Thank you for your comment. Of course, it is 10-m winds. It has been considered.

10. line 184/eq. (1) and (2): plese use τ, not ζ, to refer to wind stress. Also, x and y in eq. (3) should in subscript: τx and τy.

Answer: Thank you for your comment. It has been considered.

11. lines 196-197: why use zonally average wind instead of local winds?

Answer: We have average zonally because here, the goal was to assess the influence of the large-scale remote wind forcing on the regional circulation.

12. line 218: why is Guyana in figure 2?

Answer: Thank you for your comment. We have changed it, and said “farther north”.

13. line 221 and elsewhere: Do you mean path instead of vein?

Answer: Yes, it was “path”. We have changed it.

14. line 261: more than → longer than.

Answer: Thank you for your comment. It has been considered.

15. line 261: less than → shorter than.

Answer: Thank you for your comment. It has been considered.

16. Figure 2: you should mention in the caption that the colorbar of (c) is different than the ones of (b) and (d).

Answer: Thank you for your comment. It has been mentioned now.

17. line 291 and elsewhere: to name a current or current branch X is a horrible idea. Please, be creative and come up with a more descriptive name.

Answer: Thank you for your encouraging comment. We named it the Equatorial Surface Eastward Flow. However, because the multiple acronyms in the text, to simplify things, we called it X.

18. line 393: lowest → southernmost.

Answer: Thank you for your comment. We have changed it.

19. line 413: remove extra parenthesis.

Answer: Thank you for your comment. It has been removed.

20. line 428: currents intensity → speed.

Answer: Thank you for your comment. We have changed it.

21. line 484: Further north → Farther north.

Answer: Thank you for your comment. It has been considered.

22. line 517: recirculate → recirculates.

Answer: Thank you for your comment. It has been modified.

23. line 591-592 and elsewhere: what does • } stands for here? Standard derivation? Standard error?

Answer: It stands for the standard deviation.

23. line 630: Student test → Student's test.

Answer: Thank you for your comment. It has been modified.

24. line 670: analysed → analyzed.

Answer: Thank you for your comment. It has been modified.

25. line 743: ADCPs measurements → ADCP measurements.

Answer: Thank you for your comment. It has been modified.

26. line 753: similar with → similar to.

Answer: Thank you for your comment. It has been modified.

27. line 870: he → the.

Answer: Thank you for your comment. It has been modified.

28. line 880: confirm → confirms.

Answer: Thank you for your comment. It has been modified.

Response to Reviewer 2:

Review of "Revisiting the tropical Atlantic western boundary circulation from a 25-year time series of satellite altimetry data" by Djoirka M. Dimoune, Florence Birol, Fabrice Hernandez, Fabien Léger, Moacyr Araujo [Paper # egusphere-2022-402]

The study uses a gridded product of geostrophic surface velocities based on satellite altimeter observations to determine the seasonal and interannual variability of the surface circulation in the western tropical Atlantic. In addition to this surface velocity product, Ekman currents are used from another gridded product (GEKCO) as well as gridded surface winds from ERA5 in order to relate the geostrophic surface velocity variability to changes in the wind field. Furthermore, a sea surface temperature product is used to investigate the relation of the surface velocity variability to variability associated with the Atlantic climate modes, the meridional as well as the zonal mode.

In order to investigate the seasonal and interannual variability of the individual current branches, 6 sections are defined in order to determine the strength and position of the individual current branches and to compare their variability patterns among each other. The results show that a large fraction of the currents show a similar seasonal cycle, while a second regime seems to exist showing a somewhat different seasonal evolution, but agrees amongst each other.

An eastward current within the equatorial region and west of 42°W is identified and related to a larger scale cyclonic circulation.

The NECC is found to have a double core structure, which is somehow related to seasonal chances in the wind stress curl.

Interannual variations of the NBC seem to be opposite in the different hemispheres, which are related to the Atlantic meridional mode phases as well as the interannual variability of the NECC and nSEC at 42°W. Interannual variability of the NECC and nSEC at 32°W is related to the zonal mode phases.

Formal review:

The manuscript is well written and organized. Understanding the seasonal to interannual variability of the western tropical Atlantic surface circulation and its forcing mechanism is essential in order to understand the transport of heat, salt and other tracers across the equator and hence between the hemispheres and therefore definitely deserves attention. The methods used to investigate the seasonal to interannual variability are well explained,

however I miss a more sophisticated method to corroborate the relation of the assessed variability to the forcing mechanisms in terms of the variability in the wind field and the different phases of the Atlantic climate modes. This study cites Hormann et al. 2012, where a lot of effort is put into the investigation of this relation e.g. regression and composite analysis etc. Maybe something like this could be included here. In my opinion as gridded products are used here only and hence no need for own calibration or gridding methods, more effort should be put in the validation of these products with other available data sets.

In total I find the subject of the study important, but I recommend that some additional methods should be included in order to corroborate the findings of the study.

Answer: First of all, we thank you for your review, comments and remarks that help to improve this work and make it clearest and the understandable possible.

The goal of the paper was to take advantage of the longer time series of observations derived from altimetry data (1993-2017) to revisit the tropical Atlantic western boundary circulation by doing simple but significant analyses to study its spatial and temporal variability. In this paper, we dedicated our study only the seasonal and the interannual timescale because some recent works have been done already with the altimetry or multi-observations data at the intraseasonal timescale (eg., Aguedjou et al., 2019 and Aroucha et al., 2020).

The study was motivated by the following remaining questions in the study area:

- How does the North Brazil Current (NBC) behave along its pathway from south to north of the equator?
- What are the probable relationships between the NBC and the other surface currents, and between all these currents, the large-scale wind variability and the tropical Atlantic modes on respectively, the seasonal and interannual timescales?

By this study we wanted also to investigate with the new altimeter-derived product, the probable presence of the equatorial surface eastward current mentioned in the literature by Hisard and Hénin (1987) and Bourlès et al. (1999b).

To do so, our first objective was to use a new approach of calculation of the current's strength/intensity (based on the mean of current speeds higher than the half of the maximum speed in the velocity field) to study the temporal variability of the strength of all the currents involved in the western boundary circulation in comparison to their volume transport mentioned in the literature. To follow their spatial variability, 6 sections crossing the currents of interest are used to track the possible changes in the currents along their pathway, which is difficult to be highlighted in the overall previous studies. Among the sections, we chose one section crossing the North Brazil Current Retroflection area to also track the spatial variability of the retroflection location and compare with previous estimations.

The second objective was to investigate the relationship between the currents' variability, the large-scale trade wind field variability in the eastern basin, and the tropical Atlantic Climate modes (zonal and meridional).

As you mentioned, the biggest challenge of the geostrophic currents derived from altimetry is the question of their reliability in the equatorial region. The challenge is even bigger in the Atlantic Ocean where there are less observations (in situ, drifters: See Figure 1 below). So, we built our study on what was already done in the Pacific, considering the fact that most of the variance of the ocean currents could be explained by the geostrophic and the Ekman currents. Ralph and Nüler (1999) have shown that almost 80% of the variance of the currents observed by Lagrangian drogue drifters at 15-m depth is explained by both components: 63% for geostrophic currents and 15% for Ekman man currents. Especially for the zonal currents, Lagerloef et al. (1999) found that, in the tropical Pacific, the mean zonal currents were dominated by the geostrophic term.

For a reliable study, it was very important to choose the right product which should be closer to the reality. The choice of SEALEVEL_GLO_PHY_L4_REP_OBSERVATIONS_008_047 product is guided by the fact that in the equatorial region the currents have been calculated using the Lagerloef methodology (Lagerloef et al., 1999) which used a β-plane approximation where the Coriolis parameter is vanishing. The method was improved in this product compared to the previous ones by introducing the meridional velocities in the β component leading to more intense currents and improving the continuity of the currents within the latitudes ±5◦ N (See Pujol et al., 2016). The gridding procedure is so far the best used compared to the others (eg., Optimum Interpolation), and the performance of the grid is proved to reproduce reasonably the velocity fields (Dibarboure et al., 2011; Pujol et al., 2016).

The GEKCO Ekman currents were only used to evaluate the probable importance of the Ekman currents over the altimeter-derived currents in the equatorial region. We chose to use them because they have been already validated in the equatorial region (Sudre et al., 2013), and we mentioned it to inform and notify the work that has been done.

To investigate the relationship with the winds, we have used the ERA5 wind velocity components to compute the wind parameters (The location of the Intertropical Convergence Zone: ITCZ, the wind stress curl Strength) according to Fonseca et al. (2004). The Atlantic climate mode indices have been computed according to Servain (1991) and Zebiak (1993) to understand the possible relationship with the interannual variability of the currents.

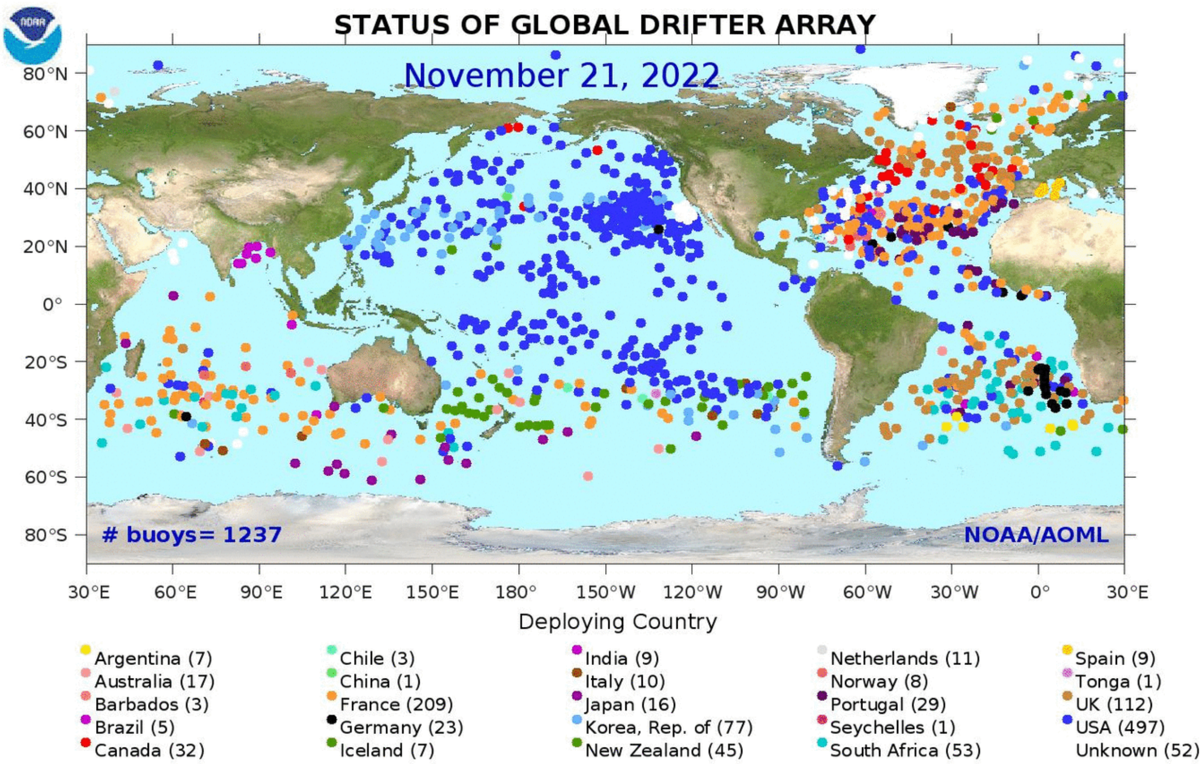


Figure 1: Status of Global drifter array on November 21, 2022, taken from NOAA website (https://www.aoml.noaa.gov/phod/gdp/)

General remarks:

As mentioned before only gridded products are used here, which are readily available. However, these products based on geostrophy and Ekman all need to be adapted within the equatorial region as geostrophy and Ekman do not hold there due to the vanishing Coriolis parameter. I think more effort and/or explanation have to be included to convince the reader that these products are trustworthy in this region e.g. maybe compare the equatorial velocities to surface velocities measured at the PIRATA buoy sites? Along these lines which data set can be used for comparison of the Amazon outflow? It is just stated

that the values of the surface velocity product there are unrealistic, but it needs some sort of reasoning to say so, before just blanking out these values.

Another point about the products: An Ekman velocity product is used, which is available and then the wind stress is calculated from the ERA5 winds. However, calculating the wind stress relies on empirical functions as explained in Line 184 and hence is crucially dependent on the formula used. In my opinion this means using an Ekman product on the one hand and calculating wind stress from some wind product on the other hand could lead to wind stress and Ekman product not necessarily fitting together, which is maybe not so nice when interpreting the results or at least this should be clearly stated somewhere. Are e.g. the empirical functions for wind stress to determine the Ekman products the same or do they differ?

To me it gets not exactly clear what are the new results from this study. For some of the results it is stated that it agrees with former studies and I might also miss some literature information, but you should definitely make point out more clearly what are the new findings here.

The detection of current X seems a somewhat new result as I understand. However, it is based on velocities from the equatorial band, which are critical for the products in use in this region (see my comment above). Hence, I think it is crucial at this point to validate the products in the equatorial region in order to make clear that this current X is not an artefact of the method to obtain the velocities in this region.

Answer: We agree with the general remark. Due to the lack of observations in the equatorial region (Figure 1 above), we initially chose to rely on the altimetry geostrophic currents. But as you suggested, we were able to find one PIRATA mooring in the equatorial region (0°N35°W) in our study area where some currents data were available only for a few months in our data time series (11/10/2017-29/01/2018: Figure 2 below).

The Comparison between the current components from the current meter at 12-m depth and the geostrophic currents (interpolated to the equator) over the period 11/10/2017-29/01/2018 (5 days means) shows as usual an underestimation of the latter (Picaut et al., 1989; Lagerloef et al., 1999, Pujol et al., 2016). The zonal components of the currents from both data show a correlation of 0.71 while the meridional ones are weaker (Figure 2a-b). The mean biases/standard deviation errors of both components are respectively 0.04 /0.11 m s^{-1} and 0.14/0.03 m s^{-1}. This result is consistent with Lagerloef et al. (1999) who found similar value in the western Pacific (0°N165°E and 0°N170°W). The authors have compared current mooring

(10-m depth zonal component) to the zonal component of the geostrophic current at the equator and found correlations of ~0.70 and biases <0.1. Our results compared to the previous ones give then credit to the altimeter-derived geostrophic currents used in this study.
Looking forward to investigate the surface eastward currents the available data of the PIRATA current meter from November 2018 to 25/03/2019 show a surface eastward current at 12-m depth during the whole period (Figure 2). This confirms the previous findings of Bourlès et al. (1999b) and justify our investigation to know more about this surface current.

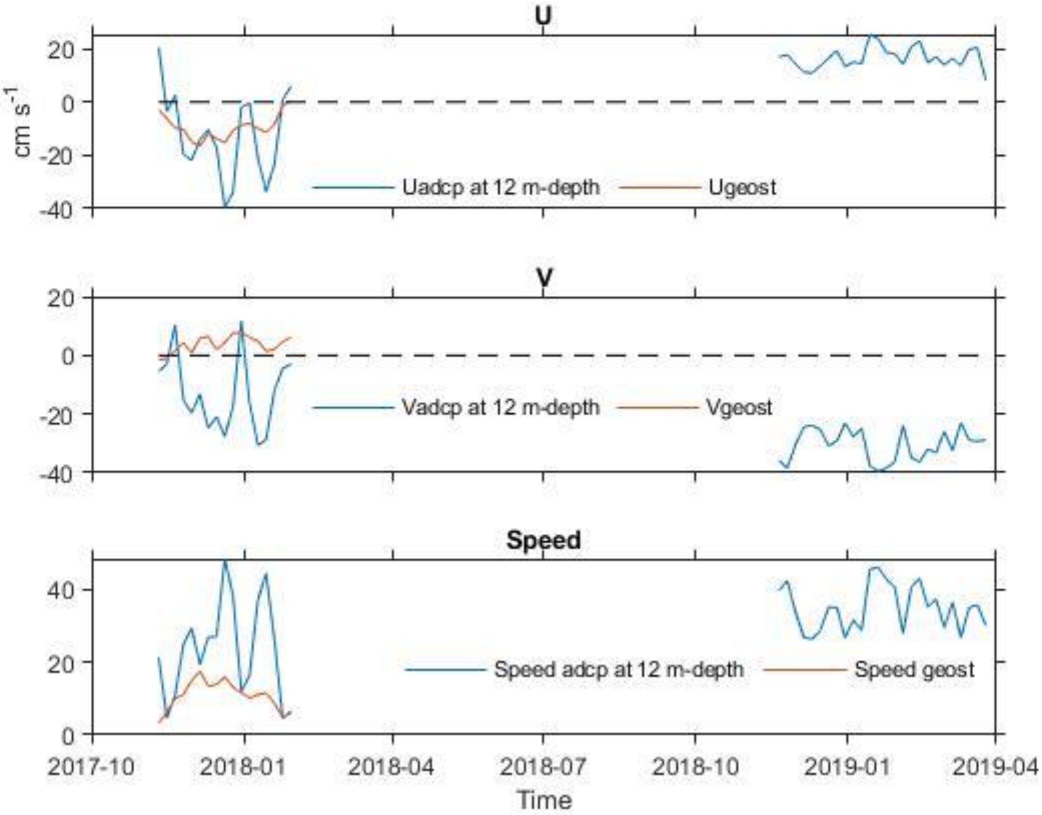


Figure 2: Time series of the PIRATA mooring current (12-m depth) and the altimetry geostrophic currents at 0°N35°W over 11/10/2017-25/03/2019 period. The top and middle panels represent the zonal and the meridional components of the currents, respectively, and the bottom panel represents the current speed. Note that the geostrophic currents are only available for 11/10/2017-29/01/2018 period.

We have also analyzed all the individual Shipboard ADCP sections from German cruises available in the study area (meridional sections at 40°W, 35°W and 32°W obtained from the data center PANGEA https://doi.pangaea.de/10.1594/PANGAEA.937809 and described in Tuchen et al, 2022) to look for the presence of the equatorial surface eastward flow shown in our study. The first depth at the surface of each section varies from 0-m to 17-m depth depending on each cruise, and we have now taken them into account in the new version of the paper to argue about the presence of the surface eastward flow in our study area. Figures 3-11 below show both the zonal and meridional components of the currents (top and bottom panels, respectively). The dashed/solid contours represent the westward/eastward currents, and the contour intervals are each 0.2 m/s for both components U (zonal) and V (meridional).

The sections at 40°W during the first half of the year (Figures 3-4) clearly show the presence of an eastward flow in the upper layer between 0°-2°N as shown using the geostrophic currents. At 35°W, this flow is extended to 2°S, with usually a northward meridional component between 0°-2°N (Figures 5-8) in the first half of the year (March-June). This is consistent with the cyclonic circulation found using the geostrophic current in our study during boreal spring. In October-November (Figures 9-10), the equatorial surface eastward flow appears weaker and less extended (1°S-1°N) with a southward meridional component between 0°-1°N. This may explain why we didn't find any cyclonic circulation during the second part of the year. At 32°W, the unique section in June show a weaker surface flow in the upper layer shifted to the south between 2°S-0°N. This is also consistent with our findings.

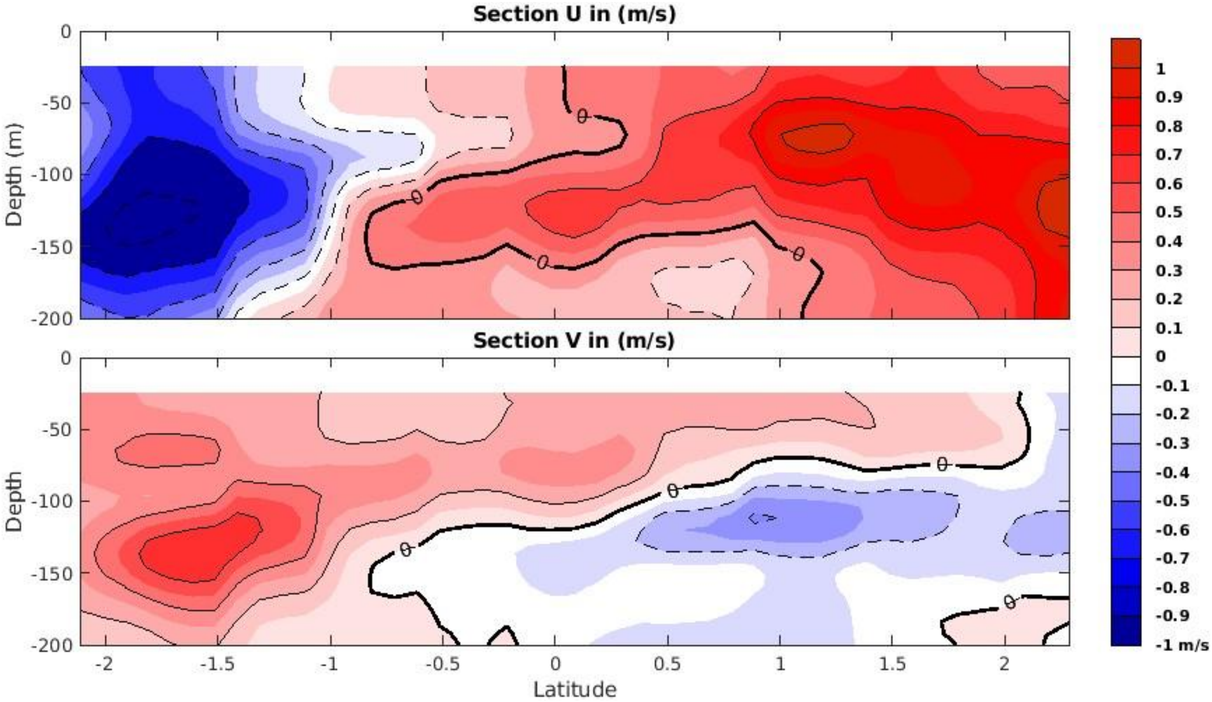


Figure 3: Shipboard ADCP section at 40°W between 2°S-2°N during 07/03/1994 to 10/03/1994 period.

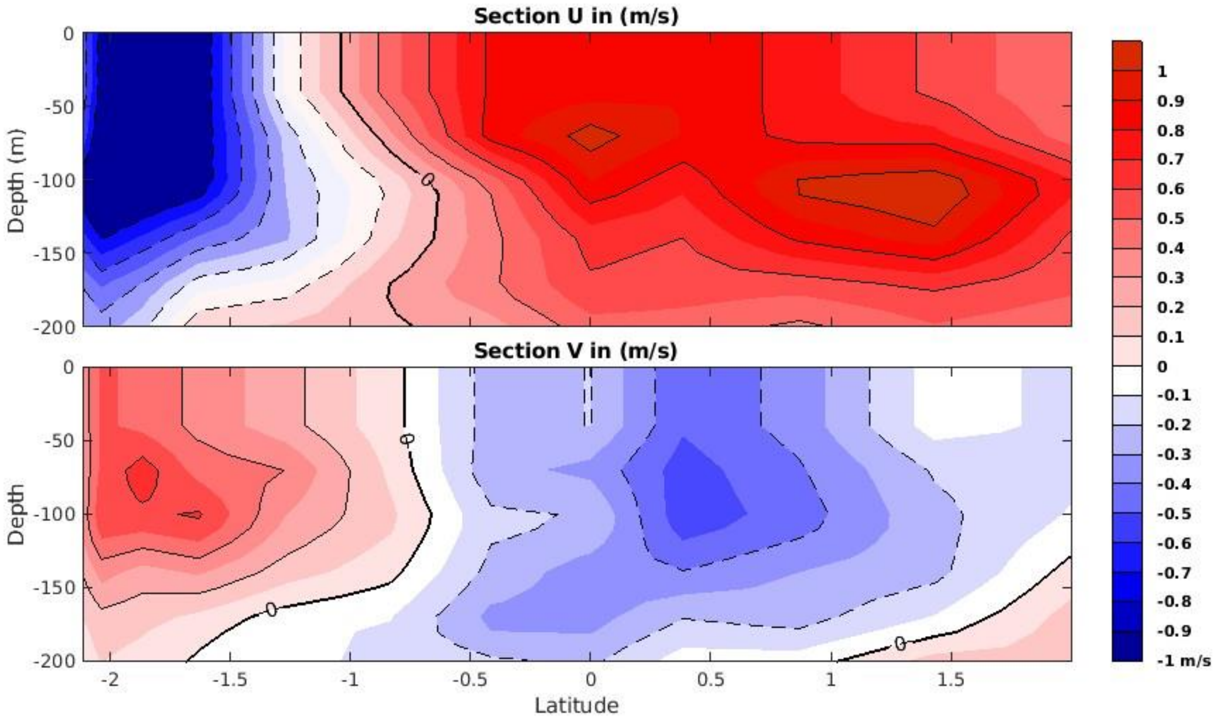


Figure 4: Shipboard ADCP section at 40°W between 2°S-2°N during 03/05/2003 to 05/05/2003 period.

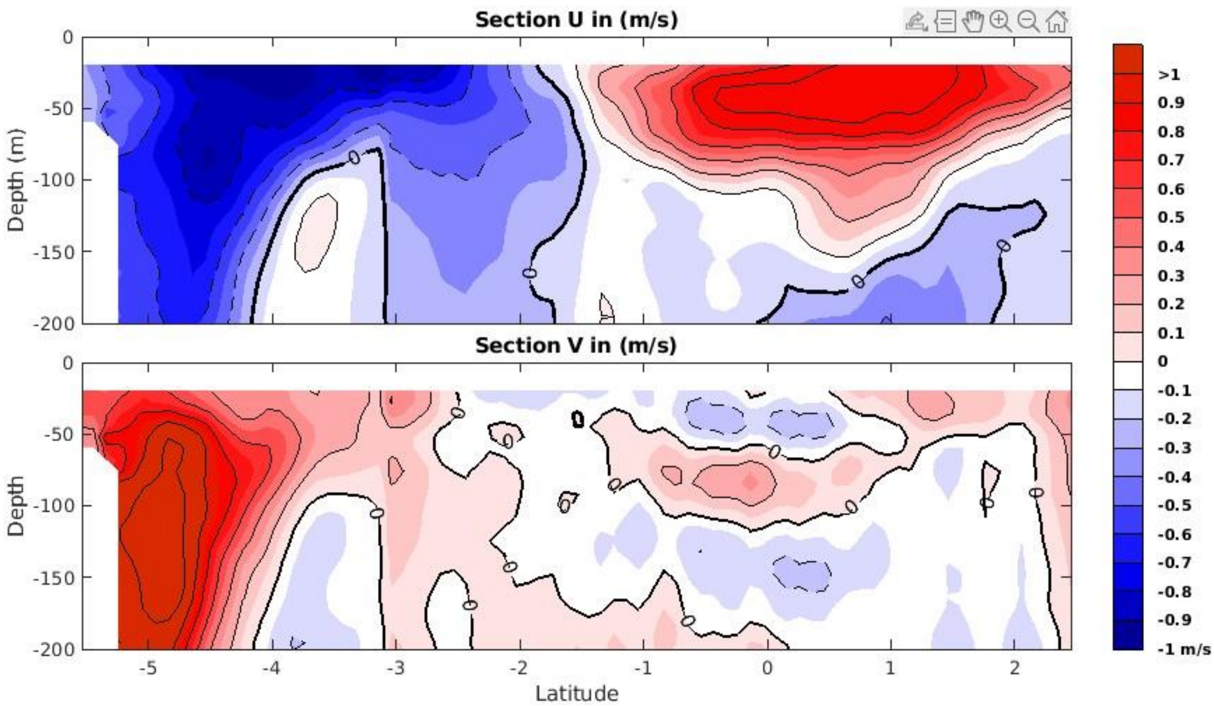


Figure 5: Shipboard ADCP section at 35°W between 6°S-3°N during 30/05/1991 to 05/06/1991 period.

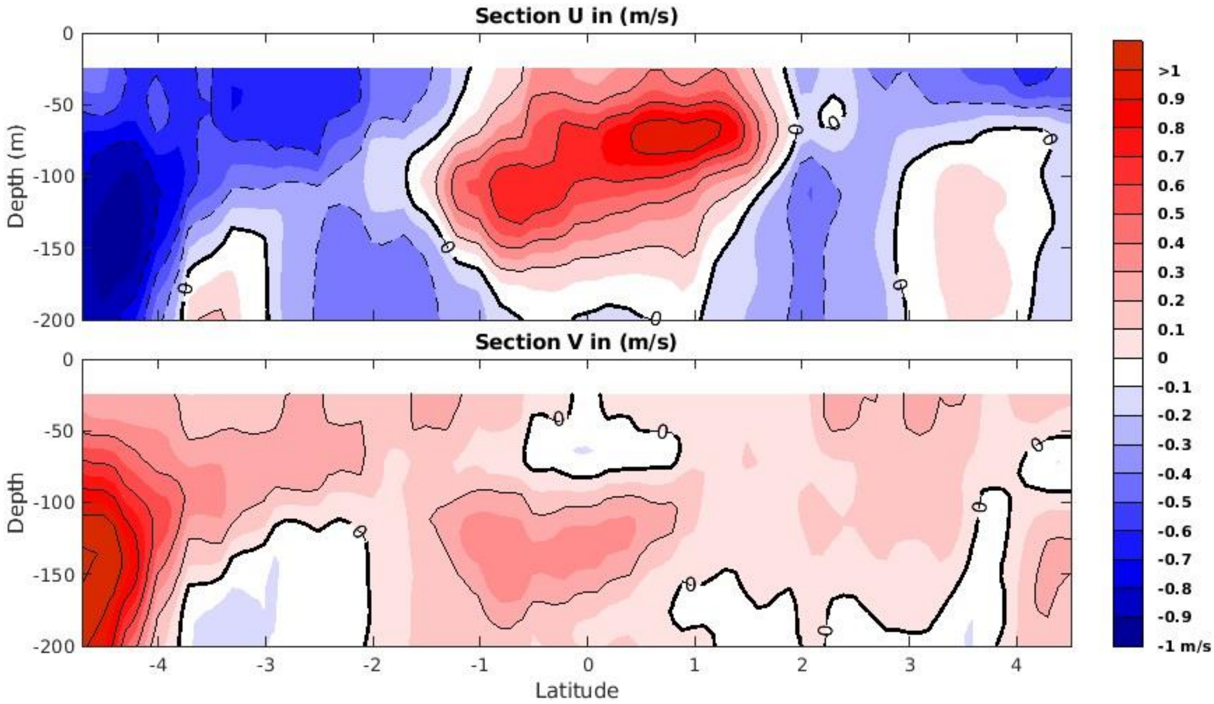


Figure 6: Shipboard ADCP section at 35°W between 5°S-5°N during 13/03/1994 to 18/03/1994 period.

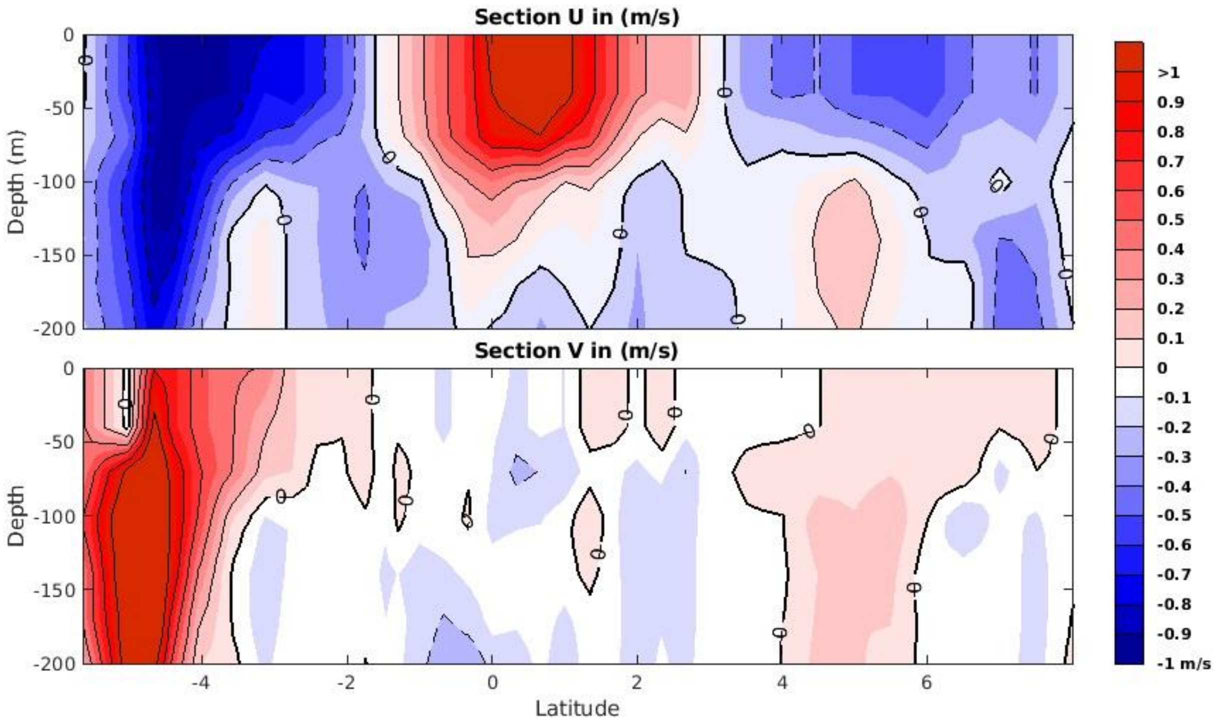


Figure 7: Shipboard ADCP section at 35°W between 6°S-8°N during 09/05/2002 to 16/05/2002 period.

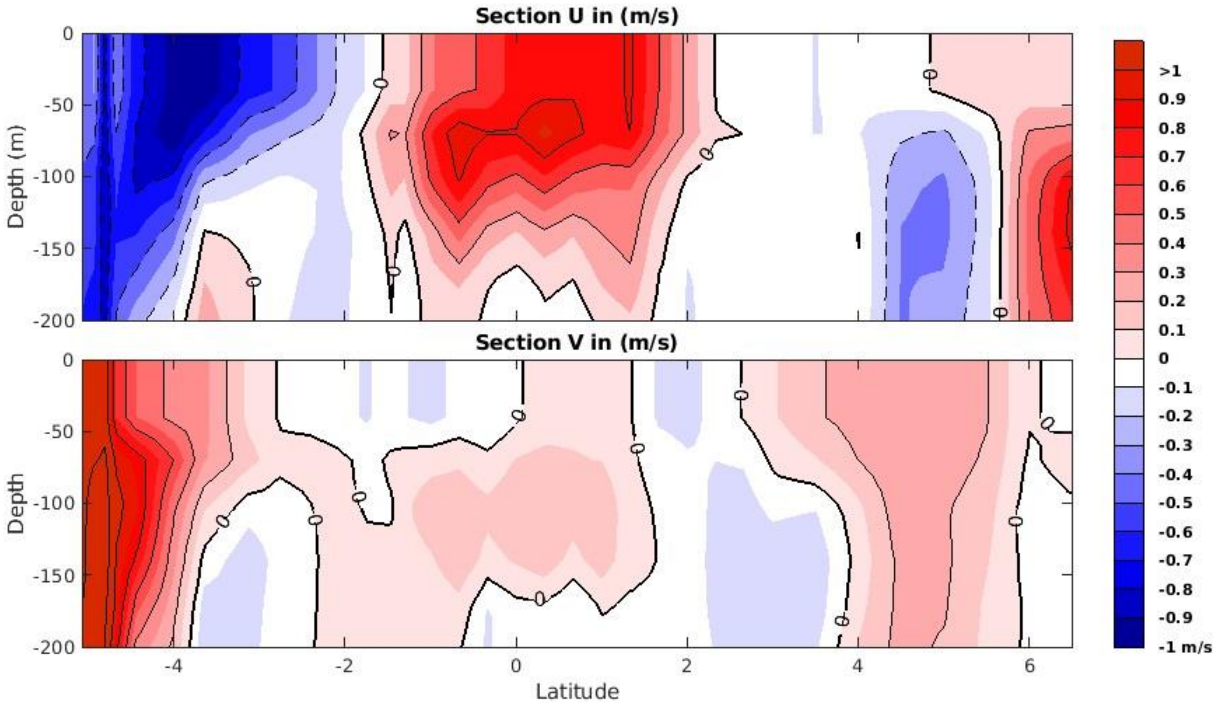


Figure 8: Shipboard ADCP section at 35°W between 5°S-3°N during 26/05/2006 to 01/06/2006 period.

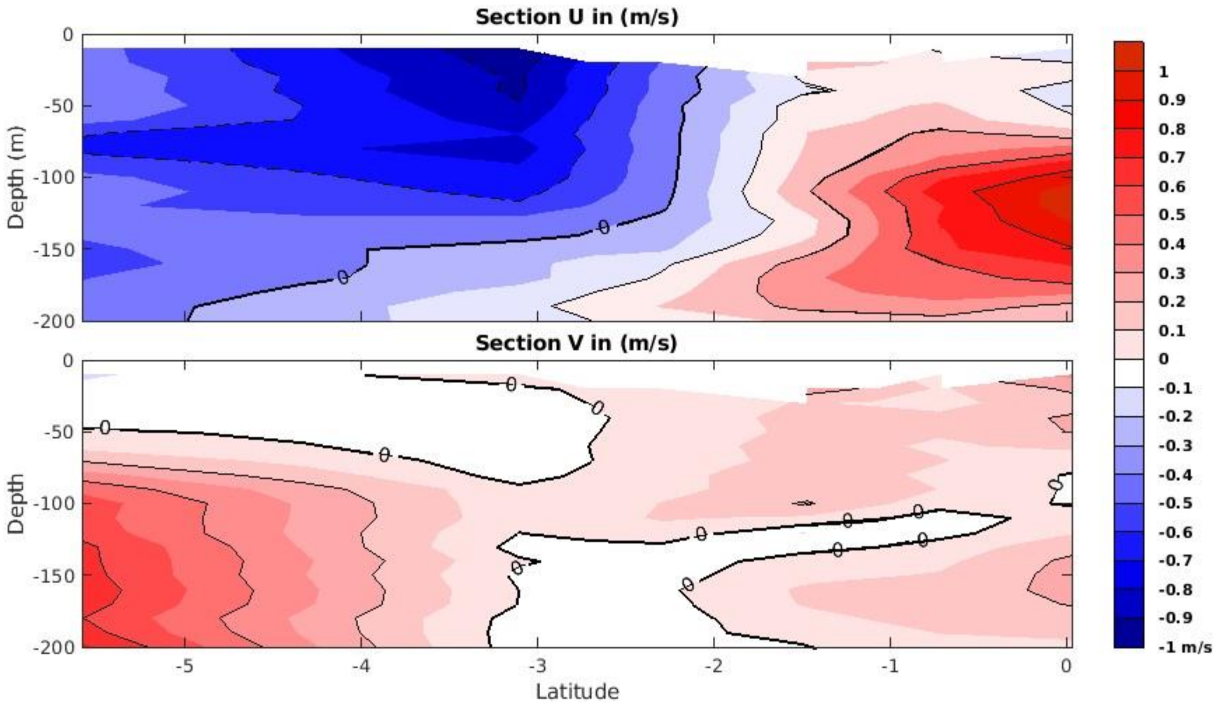


Figure 9: Shipboard ADCP section at 35°W between 6°S-0°N during 17/10/1990 to 22/10/1990 period.

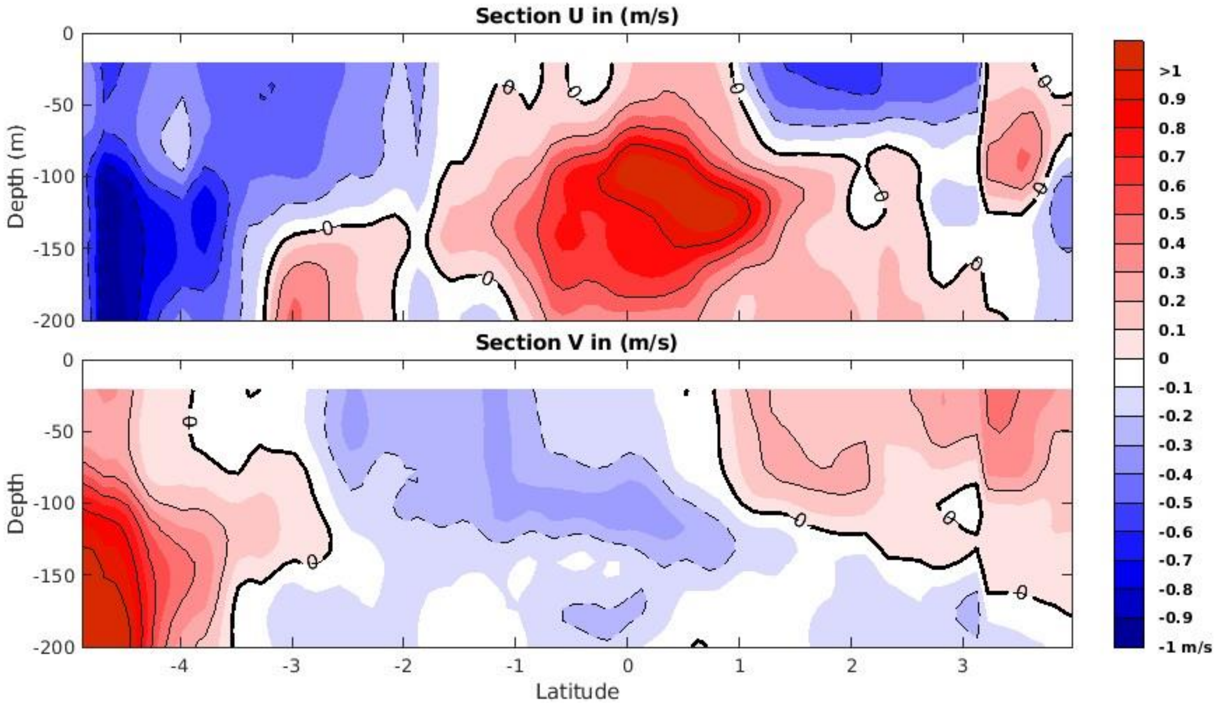


Figure 10: Shipboard ADCP section at 35°W between 5°S-4°N during 02/11/1992 to 07/11/1992 period.

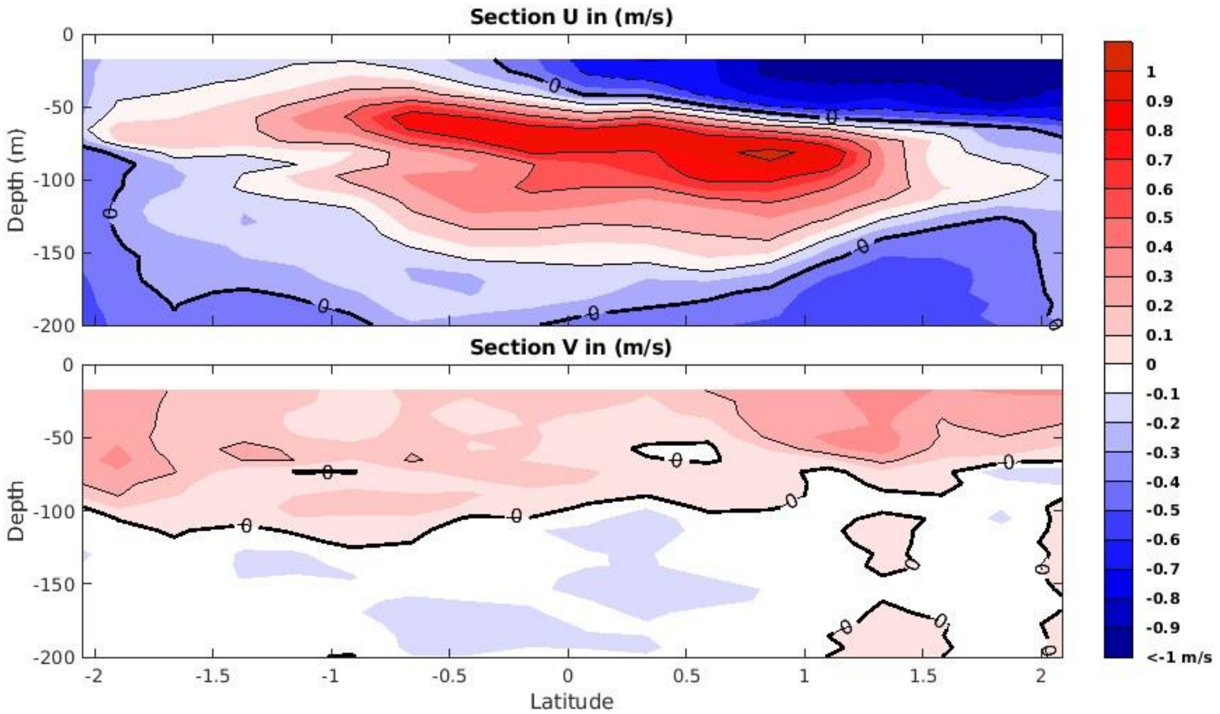


Figure 11: Shipboard ADCP section at 32°W between 2°S-2°N during 12/06/2006 to 13/06/2006 period.

Regarding the Amazon region where the data were blanked, we have removed data with highest standard deviation (>0.4), considering that, in this region the North Equatorial Countercurrent

(NECC) and the NBC have the highest variability. The map of the annual mean current speed in the region blanked were also found unrealistic with velocity higher than 2.5 m/s. We could not find any data set to confirm this consideration, but as far as our main interest is the main currents it doesn't impact the rest of our analysis.

Concerning the use of the GEKCO Ekman velocity, as mentioned above, we have used it because they have been already validated in this region (See Sudre et al., 2013). We have used the ERA5 wind to investigate the relationship with the large-scale wind variability. And as mentioned in the section 2.3. of the paper, we have considered the region covering 6° S -16° N, and 30° W-0° W, following Fonseca et al. (2004).

Concerning what are the new results, we have now highlighted them starting from the abstract. The reason why it was stated sometimes that the findings agree with former studies is first because all the studies about the seasonal variability of the currents in this region have been done with time series less than 10 years, especially for the NBC transport (Fonseca et al., 2004; Garzoli et al., 2004). So, as mentioned in the beginning of the answers, by revisiting the western boundary circulation we are trying to check the aspects of the circulation by using a new approach and comparing with what have been already done. The new results here are:

- The different seasonal variability of the NBC found north and south of the equator considering the current strength/intensity as computed.
- The relationship between the currents and the large-scale wind variability at the seasonal time scale. In the same time, we have showed the variability of the location of the NBC retroflection (NBCR) and NECC branches maximum speed (core) can be impacted by the wind variability in the whole basin differently. Regarding the NBCR flow, it has been found a secondary flow from September to December when its main core is at its northernmost location.
- And the relationship between the interannual variability of the currents and the tropical Atlantic mode.

Because of the complex ocean circulation in the tropical western boundary, we have many acronyms that are difficult to deal with, especially for a reader who is not used to this study area. To facilitate the reading, we have made a table of acronyms which is easy to refer to during the reading.

Relatively to the sophisticated analyses to be applied, the goal of our work was to use sections to try to understand the variabilities of the current strengths in the study area with simple but robust analyses. So, as it was mentioned in the paper, spectral analyses were applied on the study area to find time scales that need to be exploited. After the calculation of the current strengths/intensities and identifying some currents core location, we have obtained time series, and the study of the seasonal and the interannual variability has been based on them. Then, the correlations and the significative test were helpful to analyze the possible relationship with the wind and the tropical Atlantic modes unlike the study of Hormann et al. (2012) who focus only on the NECC region and applied the complex EOF analyses and related regression analyses to investigate the NECC's interannual variability.

In addition to these general remarks, I have some detailed remarks throughout the text:

Detailed remarks:

Line 39-41: What do you mean here? Return branch of the AMOC influenced by the wind? Maybe use the statement of Schott et al. 2005 here? "The surface circulation in this region is a superposition of the AMOC, the flow related to the Subtropical Cells and Sverdrup dynamics." In general, I miss that the STCs are mentioned here. They are shallow overturning cells connecting the tropics and subtropics and also have their imprint on the surface circulation.

Answer: Thank you for your suggestion. We have reformulated as follows: "It corresponds to a superposition of the return branch of the thermohaline Atlantic Meridional Overturning Circulation (AMOC), the flow from the Subtropical Cells and Sverdrup dynamics (Schmitz and McCartney, 1993; Schott et al., 2004, 2005; Rodrigues et al., 2007; Tuchen et al., 2019, 2020)."

Line 67-70 What about the formation of the NBC rings? This is also quite characteristic of the surface circulation and should be mentioned here.

Answer: Thank you for your suggestion. Here are the sentences we added: "The region is also known to be influenced by large mesoscale activities due to the barotropic instabilities of the currents. The most dominant mesoscale structures are large rings generated by the North Brazilian Current (NBC) retroflection (Aguedjou et al., 2019; Aroucha et al., 2020)."

Line 72: Which means in general Sverdrup dynamics apply here (why do you separate into Ekman and geostrophic velocities here?) superimposed by the AMOC and STC (see my comment above), even if west of 32°W this does not apply anymore as you mention later.

Answer: Yes, we agree. You are right. We have taken into account your suggestion and reformulated as suggested: "It corresponds to a superposition of the return branch of the thermohaline Atlantic Meridional Overturning Circulation (AMOC), the flow from the Subtropical Cells and Sverdrup dynamics (Schmitz and McCartney, 1993; Schott et al., 2004, 2005; Rodrigues et al., 2007; Tuchen et al., 2019, 2020)."

Line 86: response **to** the the wind stress curl

Answer: You are right. Thank you for the correction. It has been considered.

Line 92: So then should your study maybe focus in general more on the interannual variability? You state that this could not really be studied before, so that is new. The above part of the introduction explains that the seasonal evolution seems to the strongly related to the seasonal variability in the wind field and this was known already before then?

Answer: As mentioned in the general answer above, we wanted to revisit the whole western boundary circulation by using a new approach. So, the first thing to do was to take advantage of the longer time series available so far to understand the seasonal variability before investigating the interannual variability. As mentioned in the introduction, we know that the surface circulation basically influenced by winds. However, we wanted to understand how the large-scale wind variability impact the strength of the currents along their pathway (what was not yet done in the tropical western boundary).

Line 96-99: Maybe then also mention the relation here? They found the intensity to be related … and the core position to be related …

Answer: Thank you for your suggestion. Indeed, they found the northward shift of the NECC's core was associated with the warm phase of the Atlantic Meridional Mode (AMM) phased in boreal spring, whereas the NECC intensity was associated with the cold phase of the Atlantic Zonal Mode (AZM), phased in boreal summer. We have reformulated as follows: "They found the intensity to be related to the cold phase of AZM and the core location to be related to the warm phase of AMM."

Line 105: I again miss that the STCs are mentioned as part of the circulation system e.g. see Tuchen et al. 2019: https://doi.org/10.1029/2019JC015396
Tuchen et al., 2020: https://doi.org/10.1029/2020JC016592

Answer: Thank you for your suggestion. We have yet mentioned it in the first paragraph of the introduction and both papers have been cited. Indeed, the large-scale ocean circulation (subtropical cells) consists of the poleward Ekman transport at the surface, subduction in the equatorial in the subtropics, equatorward flow in the subsurface and upwelling along the equator and at the eastern boundary. As we are only focusing on the surface circulation, we did not want to last too long on it.

Fig. 1 How is this figure obtained? Is really only literature taken here as an underlying base for this? Or is Figure 2a the base for this? To my knowledge such a schematic should always be based on observed data, then also the length or width of the arrows can be somewhat adjusted to the observed current strength giving this a stronger basis then literature alone. Surely Fig. 2a does not include subsurface currents as EUC/NBUC so these are definitely just added because of literature, I guess.

Answer: Thank you for your remark. The figure is based on the literature. We have now reformulated better the figure title. As mentioned in the introduction, this figure aims to only show the currents involved in the western boundary circulations to introduce the region to reader before to start our study focusing on only the surface currents. Then, the strength of the currents will be discussed later, and a new seasonal map can be proposed by adjusting the width of the arrows to their observed strength.

Line 163: Maybe also state the rotation angles you used for the velocities here, if someone would want to compare results.

Answer: Thank you for your suggestion. It has been considered and the sentence have been reformulated as follows: "In this study, we considered only the cross-section component, and the rotation angles considered for the oblique sections S1-S2-S3/S4 are 45°/315°."

Fig. 2b-d: I am not quite sure whether there is a more sophisticated method to look at this, but it seems to give reasonable results. However, the figures are really small and it is hard to read the numbers. Is it maybe possible to use the same color scale?

Answer: Thank you for the remark. The figure has been improved. We did not choose another colour scale for the signal with periods larger than 600 days because we wanted to highlight clearly the interannual signal which appears to be weaker than the others as described in the paper.

Section 2.2. and Section 2.3: See my comment above; how well do these products fit together?

Answer: As mentioned in the first responses, the GEKCO Ekman currents have been chosen only because they have been already validated (Sudre et al., 2013), and we have used it only to evaluate the probable importance of the Ekman currents over the currents from the new altimeter-derived product in the equatorial region. After the validation work that has been done now, we did not find relevant to mention it anymore. So, we have removed the section 2.2 and the section 2.3 becomes the section 2.2. Consequently, the Figure 9 have also been removed.

Line 229: at every grid point? And then compared the peaks? I am not quite sure what is done here?

Answer: Thank you for your question. We have considered here the whole study area in which the currents have averaged in order have an overall view of the currents. Then, we computed the power spectral density of the corresponding daily averaged time series to find the dominant components of the currents in the study area.

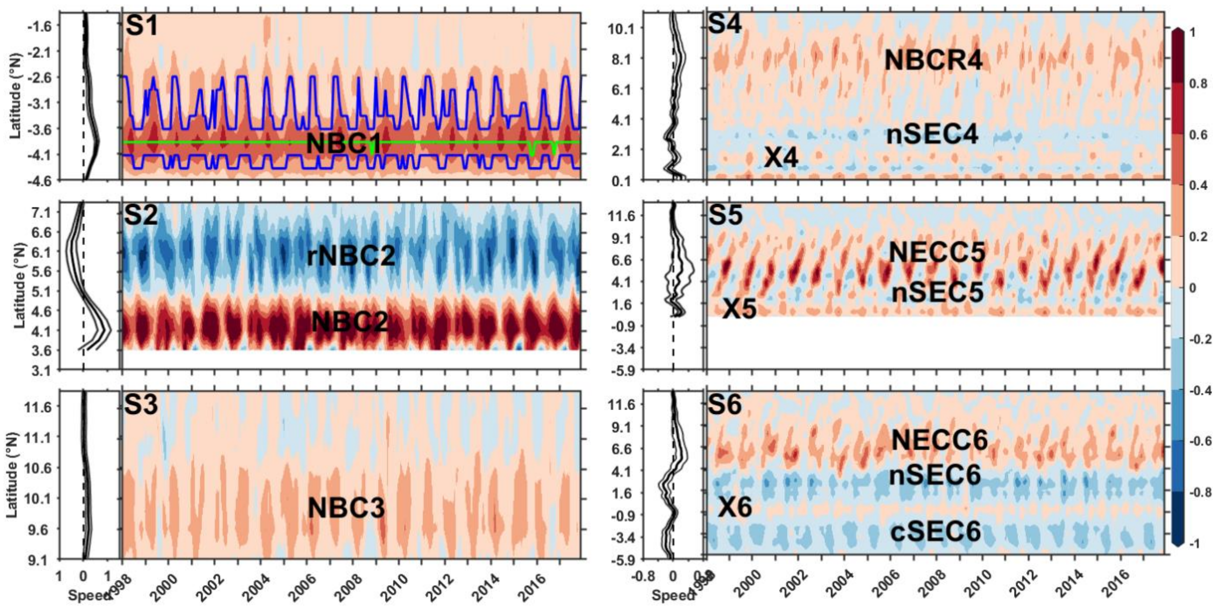
Line 243: So interannual variability is only important in a very small area? Does that mean that investigating the interannual variability of the whole region is somewhat not necessary?
Is that maybe an important result? But this then means that the new thing to look at interannual variations in the region is only important for a really small region?

Answer: Thank you for your remark. You are right, the way we formulated the sentence was ambiguous. It is clear that, compared to the seasonal and the interannual signals, the interannual signal is weaker. However, there are still things to be explored with the 25 years of data, even if the signal is strongest in the NECC area (See Fig. 3). The sentence has been reformulated as follows: “Intraseasonal fluctuations are also important in the same areas (with largest ratio of 0.44) while the interannual variability is weaker, and the highest values (>0.2) are found in the NECC area north/east of 4° N/40° W (consistent with Richardson and Walsh, 1986).”

Fig 3: For me it was hard at first to understand what is plotted here. I thought the ticks on the right of the contour plot would belong to the left hand contour plot as well and was quite irritated at first what is plotted here. For me ticks should never have 3 digits after the dot as it makes the numbers too huge. The colorbar is somehow in the plot. Green line is hardly visible. Explanation about the mean on the far left seems rather complicated in the caption. The left subplot is just the mean over the timeseries right? Why are there no data shown for section 5 in the southern region? I think the ylimits are wrong. They are the same as for section 6 although section 6 extends further south.

Answer: Thank you for your suggestions to improve the figure. It has been taken into consideration. The left subplots are the means over the times series. The section 5 was extended further south as for the section 6 to facilitate the comparison of the North Equatorial Countercurrent (NECC) along its pathway. As we can see in Fig 1., the section 5 is limited at 0 at 42°W. That is why there is no data.

The new figure is as follows:



Line 284: the seasonal and **to** a lesser extent …

Answer: You are right. Thank you for the correction. It has been considered.

Line 289: … an eastward **surface** current, where …

State here where exactly the EUC is located in this region, from which longitude is it reported until where and what is its depth extent to clarify this surface current is distinct from the EUC.

Answer: Thank you for the suggestion. It has been considered and the sentence has been reformulated as follows: "Note that in addition to the main currents mentioned in Fig. 1, between 2° S-2° N, the sections 4 to 6 show an eastward surface current, located at the same location where the EUC flows, west of 44°W in the subsurface along the equator (Schott et al., 1998). Depending on the season the EUC core is known to be located between about 100-m depth and 50-m depth when it surfaces to reach the near-surface (Brandt et al., 2016)".

Line 378: Does that mean that your definition of the current width includes both cores then in Table 1?

Answer: Yes, obviously.

Fig: 4 Why is the map of sections shown again? It is already indicated in Fig .1. and so small that anyway nothing can be seen on the figure. I suggest to remove that subplot and to enlarge the other subplots as it is very hard to read the ticks in the figures. I would put in the caption directly that this is the average seasonal cycle obtained from Figure 3 as stated in the text

Answer: Thank you for your suggestion. It has been considered and the new figure is here below:

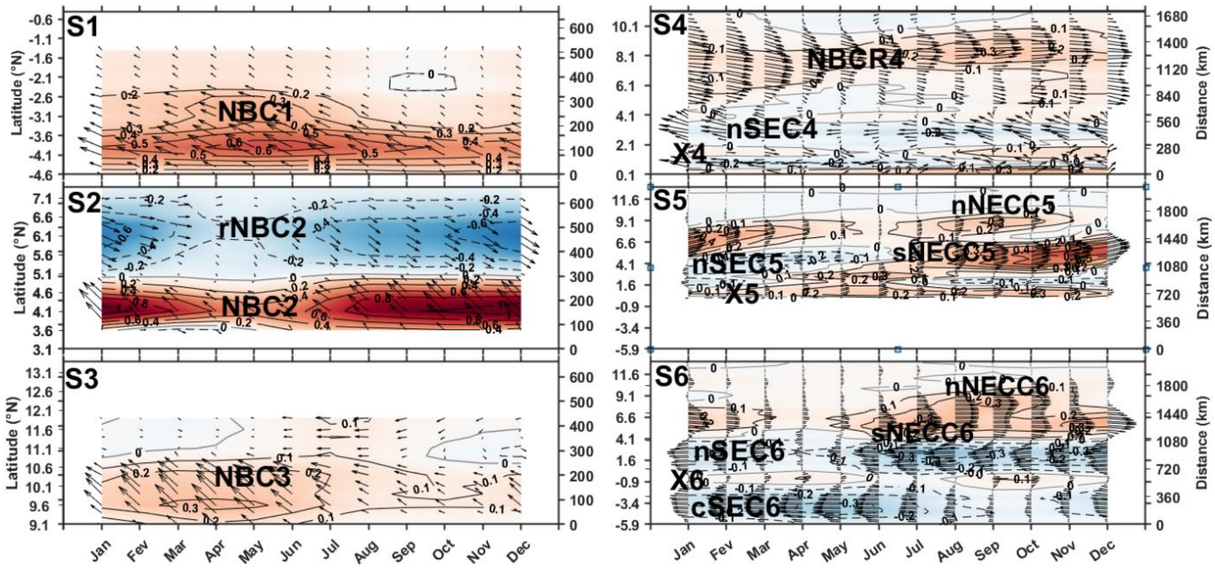


Figure 4. Average seasonal cycle obtained from Figure 3 (vectors of the currents are superimposed on the contour of their amplitude in m s^{-1}). On the right sides of each subplots, the distances from the southernmost point (in km) are indicated.

Line 409-411. Then you can remove that there and just talk about your results.

Answer: Thank you for your suggestion. They have been removed.

Fig. 5 somehow it appears odd that the NBC changes width and strength in this way. Is this somehow possible to explain. Does that have to do with the definition and the fact that there are maybe some rings present at the NBC2 location?!

Maybe this will get discussed. 1 & 3 seem in phase and 2 and 4 although 2 and 4 are in the same eddy driven regime right, so maybe this should be discussed here.

Is there somehow a better way to show all these curves or maybe do not show them all, but concentrate on the ones necessary for the key points. I find it rather hard to understand all the different curves with all these acronyms being further extended by additional letters. Also, I mixed up the lines for the core velocity and the location of the core. Maybe make current wise subplots?

Answer: Thank you for your relevant questions and comment. We have considered them and tried to respond to them in the paper as follows: "Apparently, the NBC2 width and strength seems to be linked to the nSEC intensity in the eastern basin (see nSEC6 and nSEC4 in Fig. 5b). When the nSEC is weaker, the NBC2 is also weaker and narrower. Then, the NBC2 starts growing one month later when the nSEC intensity is increasing. This shows the importance of the nSEC contribution to the NBC to the north of the equator. The delay between the nSEC and NBC2 growth can be due to the mesoscale activities more intense in the western basin (Aguedjou et al., 2019). The fact that the NBC1 and the NBC3 are in phase when the nSEC contribution to the NBC2 is lower might indicate that the NBC is more stable when the intrusion of water from the nSEC is weak. And then, most of the NBC in the upper layer tends to follow its northward route. Contrariwise, when the current is unstable because of the barotropic and baroclinic instabilities generated by the nSEC, most of the NBC flow tends to retroflects eastward. This can justify the phase of the NBC2, NBC4 and rNBC2."

Concerning the figure, it was difficult to find the good way to do it without losing the main information that we are trying to deliver. However, the idea of the acronyms table introduce in the new manuscript can be useful for the reader to understand easily.

Line 477: Is this really a continuous flow along the coast? Isn't this the track also of the NBC rings? There might appear a continuous flow in the average, but in practice the transport is accomplished by these large vortices, which are not wind-driven, but forced as you state by barotropic and baroclinic instabilities. Hence it is clear, that this does not follow the wind?!

Answer: Thank you for your comments. Indeed, you are right about the possible impact of the large vortices. However, to minimize their impact we have 4-month lowpass filtered the time series. Our results show a continuous flow, even though it is very weak except during boreal winter-spring period.

Concerning, the wind, we think that the wind has an effect. However, there also other parameters to be consider. We have then reformulated as follows: "Here, we also see that the seasonal cycles of the NBC branches north of the equator (except the NBC continuity along the Guyana coast) seems to follow the remote wind stress curl strength with a delay of one to four months (Fig. 5a-f). Because of the instabilities of the region, this delay should be impacted by the mesoscale activities and/or wave propagations in the region (Fonseca et al., 2004)."

Line 481: Here you mention the rings. I think you have to discuss this more clearly.

In general, all these acronyms make you go crazy, but I do not have a good suggestion about how to change this.

Answer: Thank you for your suggestion. We have considered it and have add to the paragraph: "The root mean square (rms) of the monthly mean values of its location (Fig. 5c) is nearly constant (~2.3°), and is consistent with the evidence that there may not be a preferred season for NBC ring formation (Garzoli et al., 2003; Goni and Johns, 2003). Indeed, Garzoli et al. (2003) have shown using inverted echo sounder observations that there was a link between the rapid northward/southward extension of the NBC retroflection and the shedding of the rings in this region."

Line 504: What do you mean here? Eastward surface flow corresponds to the mixing of subsurface flow? I do not really understand what you want to say here.

Answer: Thank you for your question. We did not express well ourselves. The sentence has been reformulated as follows: "Urbano et al. (2008) showed with ADCP data at 38° W that the eastward NECC cycle may start in this region when the EUC is shallower and further north, and seems to be connected also to a shallower NEUC during this period of the year."

Line 519-520 nSEC mixes with NEUC? For my understanding the NEUC is a subsurface flow. Does it have a surface extension then at this time? Otherwise, I do not quite understand how nSEC and NEUC are supposed to mix. Please clarify.

Answer: Thank you for your question. To better understanding, we have reformulated our sentence as follows: "The presence of the sNECC flow in April-May may suggest that the NECC flow might be initiated by an eastward recirculation of the nSEC which flows on top of the NEUC during this period."

Line 529-530: Isnt that obvious? For my understanding you only have the nSEC because the Trades traverse the equator as the ITCZ is positioned always north of the equator. The seasonal migration of the ITCZ therefore mainly affects the seasonal cycles for the nSEC and the NECC and not as much for the other parts of the SEC or not? I think you should always discuss the seasonal cycles you obtain in conjunction with the changes in the large scale circulation.

Answer: Thank you for your comment. Yes, it obvious. We wanted to highlight the aspect of the circulation that you described, and also show that along the nSEC pathway that, there are some differences, especially west of 32°W where its seasonal cycle seems to be influenced by the cyclonic circulation during boreal spring (Which is discussed later in the discussion section). We have reformulated as follows: "Obviously, the cSEC and nSEC which are two branches of the westward SEC do not have the same seasonal cycle (Fig. 4S4, S5, S6). This is due to the fact that, in the northern hemisphere, the nSEC is affected by the southerlies which cross the equator, inducing a migration ITCZ location. However, the cycles of the nSEC4, nSEC5 and nSEC6 have maxima at different periods of time. At 32° W, the nSEC (nSEC6) increases from April to reach a maximum of ~ 0.3 m s^{-1} in August, following the migration of the ITCZ (Fig. 5b, f). During this time, at 42° W, the nSEC (nSEC5) migrates northward, and its intensity decreases until July, when it almost disappears. The eastward flow X then appears (Fig. 4S5). The nSEC5 is observed again after July, increases and reach a maximum of ~ 0.2 m s^{-1} in March (Fig. 4S5, S6 and Fig. 5b)."

Line 530: the nSEC does not cross the S4 section at a right angle. Couldn't that also have imprints on not being able to correctly determine the seasonal cycle of the intensity? Okay this is mentioned in line 542. I would maybe point this out beforehand and in any way, I think for all this description maybe think about what is important to say and what is maybe not; in this case maybe do not consider the SEC part from S4?

Answer: You are right. This is why we did not mention the nSEC4 until the end of the section. However, knowing that it could draw the attention of any serious reader, we chose to notify why it shows this variability at the end.

Section 4.4: See my general remark. You have to clarify how trustworthy your geostrophic surface velocities are in close proximity to the equator and whether then this current "X" is real or also could be an artefact.

Answer: Yes, you are right. A response has been given above, after the general remark and been considered in the paper. We think that this geostrophic current product is trustworthy in close proximity to the equator. We also think that this current is real and may be even underestimated (See Fig. 2 above).

Figure 6 is more what I would envision for Figurer 5 on seasonal scales concerning a subplot for each current vein.
Maybe better to remove the seasonal cycle in Figure 6 though to better see interannual variations? Its rather hard to see anything beyond the seasonal signal in these time series; this

seems to have been done in Fig. 7 for some of the currents. Maybe somehow combine Figure 6 and 7?

Answer: Thank you for your suggestions. Because of the complex circulation of the tropical western boundary and its multiple currents, it was very difficult to make the figures simple and give all the information necessary as you have mentioned it before. We have tried to combine Figures 6 and 7 as suggested, but the resulting figure appears rather harder to understand. So, we chose to not combine them.

Line 592: What do the deviations stand for? Standard deviation? Standard error? Why do you state all these numbers in the text? What do we learn from that?

Answer: These deviations stand for the standard deviation. We found important to mention them because, it shows how the intensity/location of the currents varies over the time period of 25 years. And, this supports the importance of the interannual variability study.

Line 599: as mentioned above this should be clearly seen when the seasonal cycle is removed.

Answer: Yes, we can see it in Figure 7. Both Figures 6 and 7 could have been put together, but to avoid having much information in one figure, we have separated them.

Line 600: Isnt it obvious that they should be correlated, if the NBCR feeds the NECC? In any way which time series did you correlate. I thought you want to look at the relation on interannual time scales, but I think that a 3 month running mean does not remove the seasonal component. Along that lines before you say that interannual variability is only important in small region which should maybe imply that the correlations to the other current bands on interannual time scales must be very small? I think this needs clarification.

Answer: Thank you for your comment. As mentioned it in one of the responses above, we didn’t want to say that there no interannual variability at all in the other regions. As we can see in Fig. 3 of the paper, there is clearly year-to-year variations. Here, the sentence also was not well formulated. But to not create confusion in the reader head, we have removed this sentence. Concerning the NBCR and the NECC, we know that the NECC partially fed by the NBCR, but does not totally depend on him (Bourlès et al., 1999a; Goes et al., 2005; Verdy and Jochum, 2005). So, we found it important to be mentioned. This information might mean that, in the near-surface layer, the NECC depend more on the NBCR. At this stage, we were only trying to highlight in the time series the variability from year-to-year to justify the importance of the interannual study and introduce the subject.

Line 617-619: Didn't you just say that the NECC and the NBCR were correlated and now no obvious relation can be seen. Or maybe you mean no relation between core position and strength is obvious? I think you have to rephrase this to make clear what is meant.

Answer: Thank you for your comment. We wanted to talk about the relationship between the position and the strength. It has been reformulated as follows: "No relationship was found between the intensity of the NECC branches or of the NBCR flows and their location."

Line 620: Would you expect such a relation necessarily? What would be the mechanism pushing the core to a certain position and in the same time influencing the intensity?

Answer: We were expecting a relationship between the NECC intensity and its core location. This would have confirmed that both the intensity and the core location are influenced by the wind stress curl strength. But, the fact that it is not the case might mean that the NECC intensity and its northward/southward location are not driven by the same mechanism at the interannual timescale.

Line 624: Here I find more methods/analysis are necessary, see my general comment above. You cite Hormann et al. 2012, where an extensive analysis of the interannual NECC variability and its relation to the Atlantic climate modes was made. Along that line: What are your new results about this? In Hormann et al. 2012 they use CEOF analysis, regression and composite analysis to determine this relationship.
Here only correlations of different timeseries is used, which I think is not sufficient as this extensive study about interannual NECC variability and its relation to the climate modes (Hormann et al. 2012) already exists.

Answer: Thank you for your comment. We understood your concern. As mentioned in the response of the general comments, because we are dealing with many currents, the goal was to look for the possible relationships in a simple way possible. This work also aims to give some subjects to explore further on a case-by-case basis. As we are dealing with individual sections in different locations, and are considering the current strength/core location times series for our approach, the application of CEOF and its related regression and composite analysis could not be applied.

So, the spectral analysis has been done in our work to extract the signals that was needed, and we tried to look for the relationship between the time series by doing correlations with significative tests. The method used here to look for the relationship between the current strength/core location is similar the composite method. Knowing the proper period of the AZM and AMM events (lasting about three months), it is possible to correlate only these events with the 3-month means of the current anomalies (centered each month of the year) to see how the year-to-year variations are linked with. But as you suggested, since some possible relationships have been found, in the future studies to come on a case-to-case basis, we can consider sophisticated method as the CEOF to deepen the knowledges.

We have reformulated better the whole paragraph as follows: "To investigate the relationship between the AMM, the AZM, and the year-to-year variability of the characteristics of the different currents at different locations over 1993-2007 period, we computed the three-month average anomalies centered each month of both the time series of the anomalies of the currents and of the climate mode indexes (so-called 3-month anomaly time series). So, the AMM and AZM peak events (respectively, March-April-May and June-July-August) have been correlated with the 3-month anomaly time series of the currents in order to learn more about their possible relationship at the interannual timescale in the study area (Figures not shown). Only the correlations greater than ±0.5 and which have been found significant with 95 % of confidence level, performing the Student's test are discussed below (listed in Table 2)."

Line 625: I guess you mean 1993-2017?

Answer: Yes, indeed. Thank you for notification. It has been considered.

Line 628: What to you learn about the spatial characteristics of the interannual variability in the study area when you only correlate time series? See my comment above I think you need some sort of regression and composite analysis for that.

Answer: Thank you for your comment. The sentence was not well formulated. We have reformulated as follows: "So, the AMM and AZM peak events (respectively, March-April-May and June-July-August) have been correlated with the 3-month anomaly time series of the currents in order to learn more about their possible relationship at the interannual timescale in the study area". The whole paragraph is in the previous response.

Table 2: In the beginning of your study you show that interannual variability is basically only elevated in the NECC region. Please clarify for what kind of correlation you investigate the time series, this somehow does not get clear for me.

Answer: Thank you for your remarks and comments. They have been taken into consideration and the sentence have been reformulated to clarify things.

Line 701: I am not sure I understood everything. Maybe instead of all this neg/pos decrease/increase describe the relation in one way and then say vice versa?
But do I understand correctly that all these relationships between the currents and climate modes were already found and explained? So, what is new? Please highlight this more clearly.

Answer: Thank you for your comment and suggestion. There is a misunderstanding. Indeed, the study of the Atlantic climate modes in relation with the wind anomalies have been already explained by Cabos et al. (2019). However, the relation between the current and the climate mode is a new result. So, this paragraph is discussing the meaning of the findings in order to understand the probable mechanisms behind the relationships. The whole paragraph has been reformulated as follows: "Referring to Cabos et al. (2019), the relationships found between the currents and the AMM show the influence of the strengthening of the southeast trade winds on the southward migration of the nNECC core at 32°W, whereas the NBC intensity between 3°-5°S and the equatorial eastward flow X intensity west of 42°W decrease, and vice versa. Conversely, the strengthening of the southeast trade winds may influence the northward migration of the sNECC core at 32°W, whereas the NBC2, sNECC6 and nSEC6 intensities increase, and vice versa. Referring to the same authors, the relationship with the AZM indicate the probable influence of the positive westerlies anomalies in the western part of the basin on the negative anomalies of the sNECC and nSEC intensities at 42°W, and vice versa. Concerning the eastward flow X at 32°W the relationship with both the AZM and the AMM modes indicates its strengthening during the concurrent events of positive westerlies anomalies in the western part of the basin and the negative southerlies winds anomalies, and vice versa."

Figure 8: I do not understand what is shown here in color. Probably you mean it is speed = sqrt (u^2+v^2) multiplied with the sign of the **zonal** velocity or not? If there is also the sign of meridional component in it would be confusing, but the plot looks like zonal?

Answer: Thank you for the remark. Yes, what is shown in colour is the speed multiplied with the sign of zonal velocity to see either the current is westward or eastward. We have reformulated this part of the caption as follows: "The velocity vectors are superimposed on the speed multiplied by the sign of their zonal components (m s^{-1})."

Line 744-751: I think I do not understand this? So absolute velocities is something you do not have right. They should be something like Ekman+geostrophy, but again keep in mind that both a problematic at and close to the equator. Is this part then something like a validation that you compare this with other studies and say that they are maybe somewhat weak here? This could then also mean that your current X is not really trustworthy then? See my general remark about that.

Answer: As said in the introduction, our investigation on this eastward surface current was inspired by what was mentioned in the literature. We know that in the equatorial region, the dynamics is more complex. But, as shown at the beginning of our response, especially in Fig. 2 to 11 above, the observations clearly show an eastward flow at the surface. It is clear that there are other parameters to be considered. However, if we assume that about 78% of the variance of the ocean currents can be explained by the geostrophic and Ekman currents (Ralph and Nüler, 1999), we can be more optimistic. Fig. 2 shown here, also show that this product can reproduce approximately well the current at 12-m depth.

We have reformulated the sentences as follows: "In this study, the seasonal maps of the near-surface Ekman currents (figure not shown) showed westward currents with higher amplitudes in this equatorial band (larger than 0.2 m s^{-1}) compared to X, mostly east of 32°W. Then, we conclude that the near-surface velocities found here in the equatorial region should be underestimated, particularly in the eastern basin. This is consistent with the strengths of the X current found in Fig. 5b."

Line 752-755: but only the geostrophic component of this flow and again its maybe not well defined in this product.

Answer: As said in the beginning of our responses, the technic used in the equatorial region is based on the β-plane approximation of the Lagerloef methodology (Lagerloef et al., 1999) and the results seems to quite fit with the observations (Fig. 2 here) even if we don't have a longer time series of currents data. So, considering the results of the Fig. 2 here, we can give credit to the data, even if there are things to further deepen.

Fig. 10 so in this case the schematic is based on Fig. 8 as hopefully Figure 1 is based on 2a, but you need to keep in mind that you only show the geostrophic component! Or did you combine fIgure 8 and 9 to come up with Fig. 10? You can not really add the NBUC und EUC in this case as you have not included them in Fig. 8; you have the surface geostrophic currents, so the NBUC und EUC are not part of it. Why are there 3 arrows now for the NECC. I thought you divide into nNECC and sNECC what is the middle one for then?

Answer: We based Fig. 10 on Figure 9. But before, we have evaluated the importance of the Ekman currents on the geostrophic currents, and the results were almost the same. We didn't add the EUC. However, we thought that it is important to show the NBUC since it influences also the NBC cycle south of the equator. We leaved the size of the corresponding arrow the same, to not argue about it.

Line 841-843: Then maybe some regression for the individual branches should be performed here to see whether the results of Hormann et al. 2012 hold for the individual parts or not?

Answer: Thank you for your suggestion. As mentioned in the beginning of our responses, the goal was to analyze the spatial and temporal variability of the surface currents in a simple way possible since we are dealing with many currents. Our approach was to compute the strength of the currents and try to understand the relationships between them, and also with the large-scale wind variability and the tropical Atlantic climate modes. So, we have performed spectral analyses, then considered the signals mentioned in the introduction, and analyzed the relationships based on statistical tests. It is easier to do the analyses performed by Hormann et al. (2012) when you are concerned by the variability of one current. So, the authors have used the complex EOF and the corresponding regression analyses on maps in the NECC domain to investigate the variabilities of the current.

Line 852: interannual variations only important in the Northeast I thought?

Answer: We thank you for your comments. We haven't expressed well our idea. It has been reformulated to avoid the confusion as shown in one of the answers above.