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.

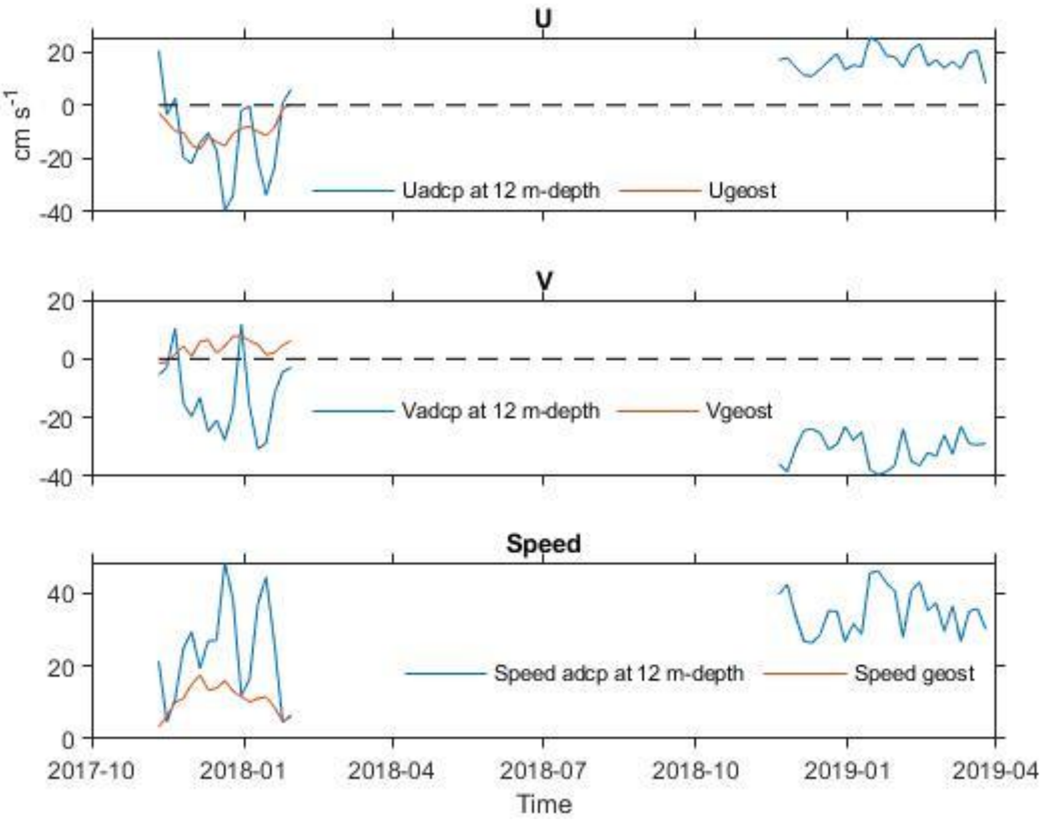


Figure 1: Time series of the PIRATA mooring current (12-m depth) and the altimetry geostrophic currents at 0°N35°W over 11/10/2017-25/03/2019 period. The top and middle panels represent the zonal and the meridional components of the currents, respectively, and the bottom panel represents the current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

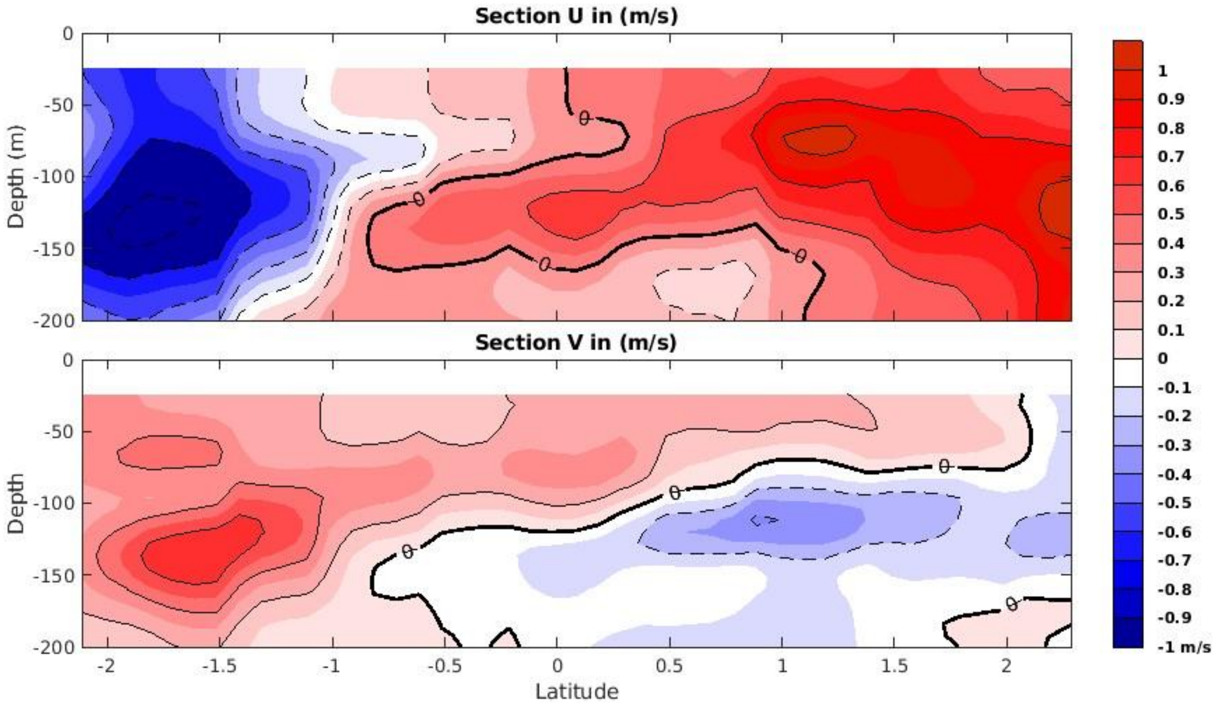


Figure 2: Shipboard ADCP section at 40°W between 2°S-2°N during 07/03/1994 to 10/03/1994 period.

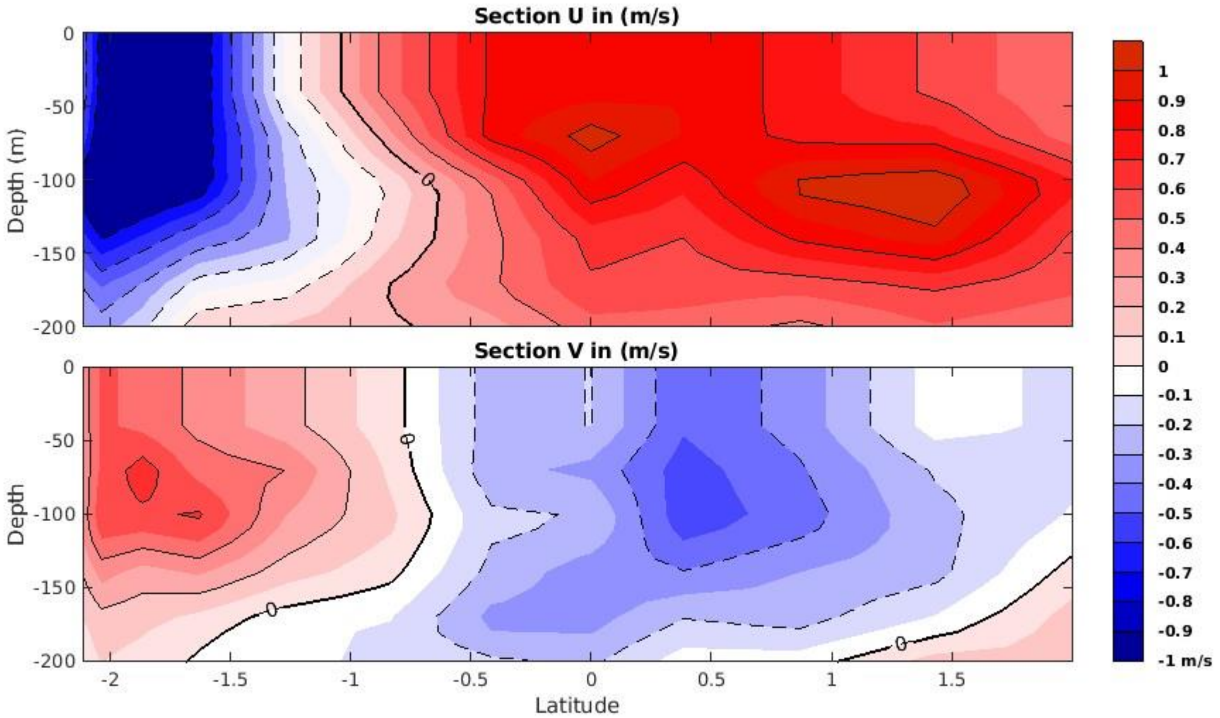


Figure 3: Shipboard ADCP section at 40°W between 2°S-2°N during 03/05/2003 to 05/05/2003 period.

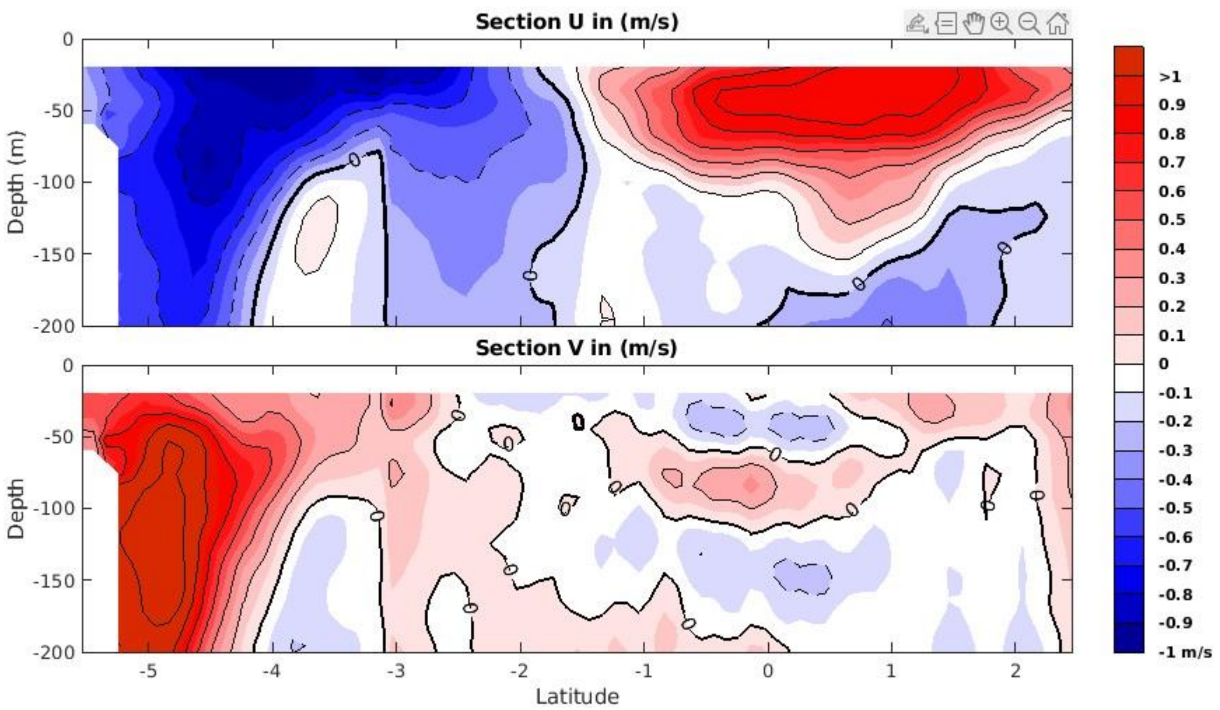


Figure 4: Shipboard ADCP section at 35°W between 6°S-3°N during 30/05/1991 to 05/06/1991 period.

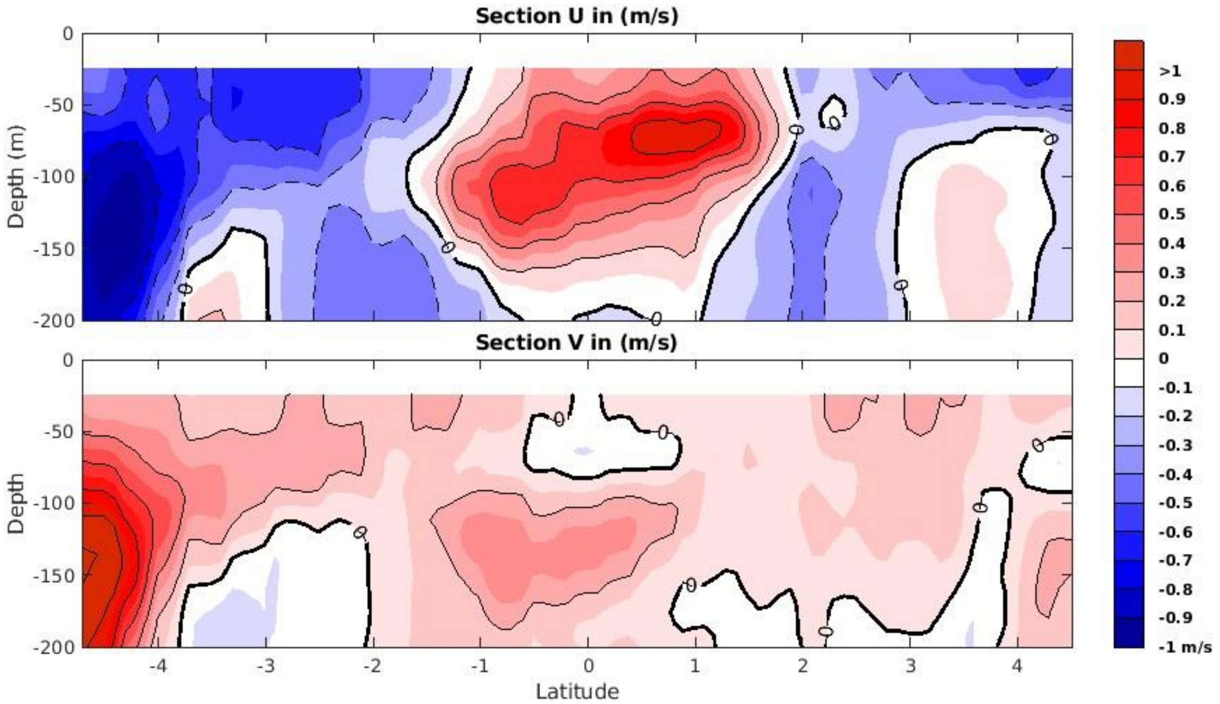


Figure 5: Shipboard ADCP section at 35°W between 5°S-5°N during 13/03/1994 to 18/03/1994 period.

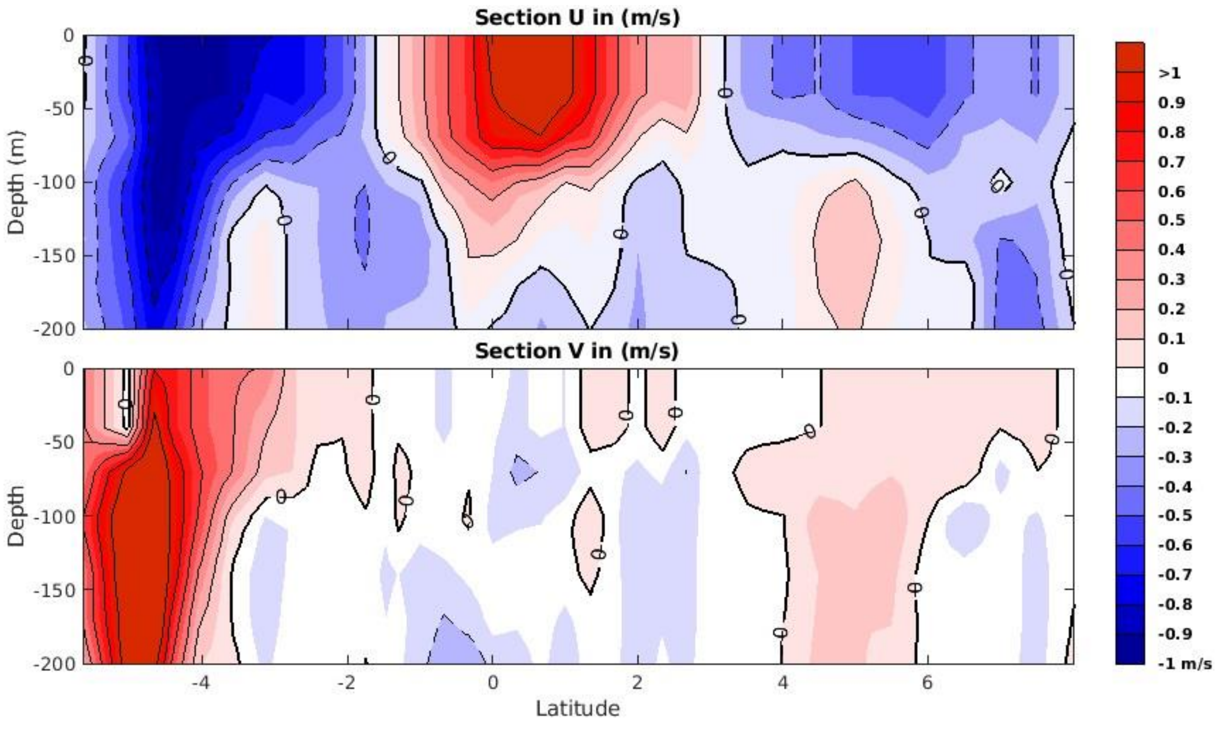


Figure 6: Shipboard ADCP section at 35°W between 6°S-8°N during 09/05/2002 to 16/05/2002 period.

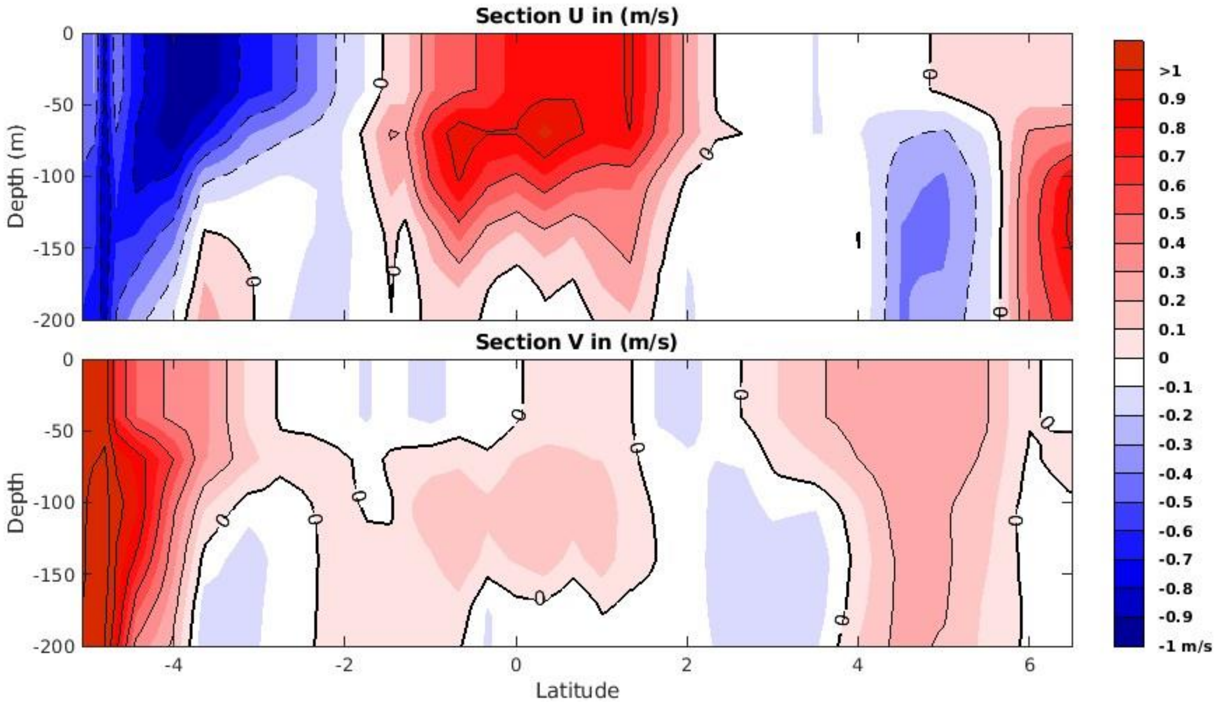


Figure 7: Shipboard ADCP section at 35°W between 5°S-3°N during 26/05/2006 to 01/06/2006 period.

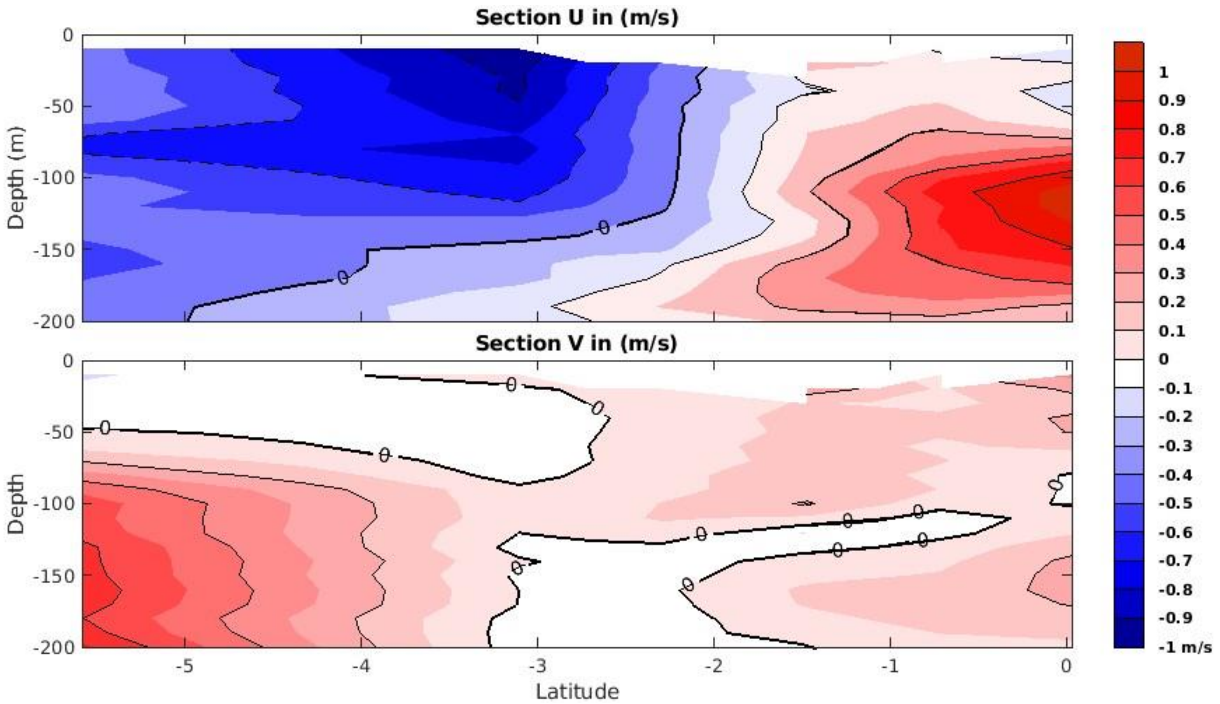


Figure 8: Shipboard ADCP section at 35°W between 6°S-0°N during 17/10/1990 to 22/10/1990 period.

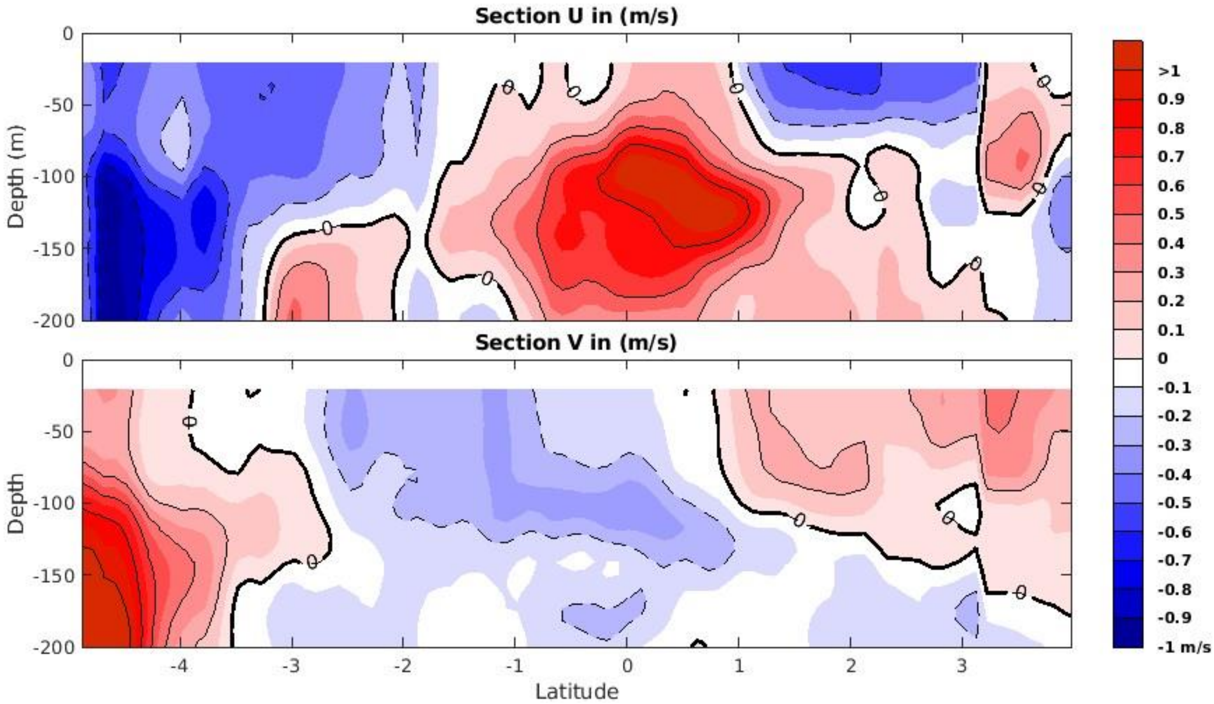


Figure 9: Shipboard ADCP section at 35°W between 5°S-4°N during 02/11/1992 to 07/11/1992 period.

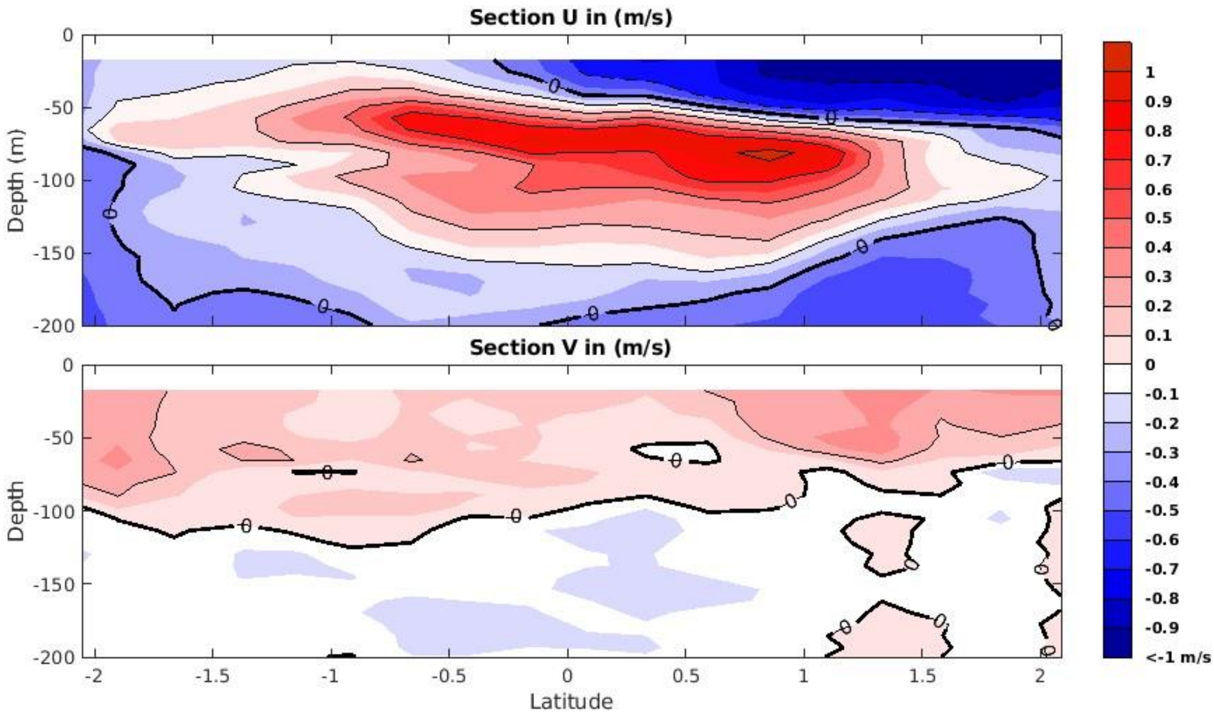


Figure 10: Shipboard ADCP section at 32°W between 2°S-2°N during 12/06/2006 to 13/06/2006 period.

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.

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:

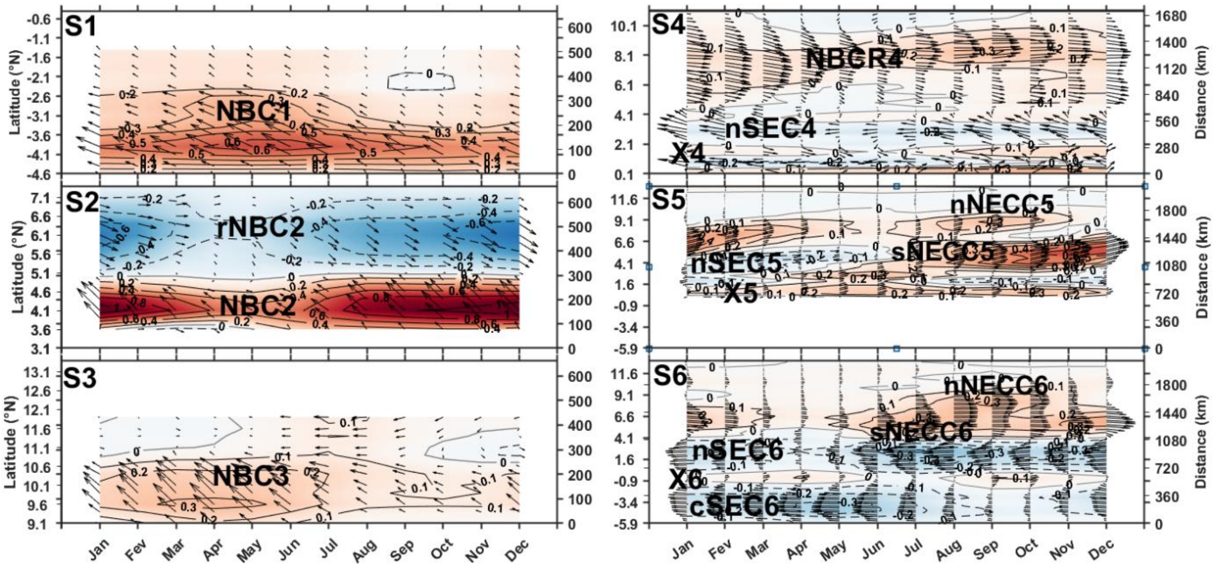
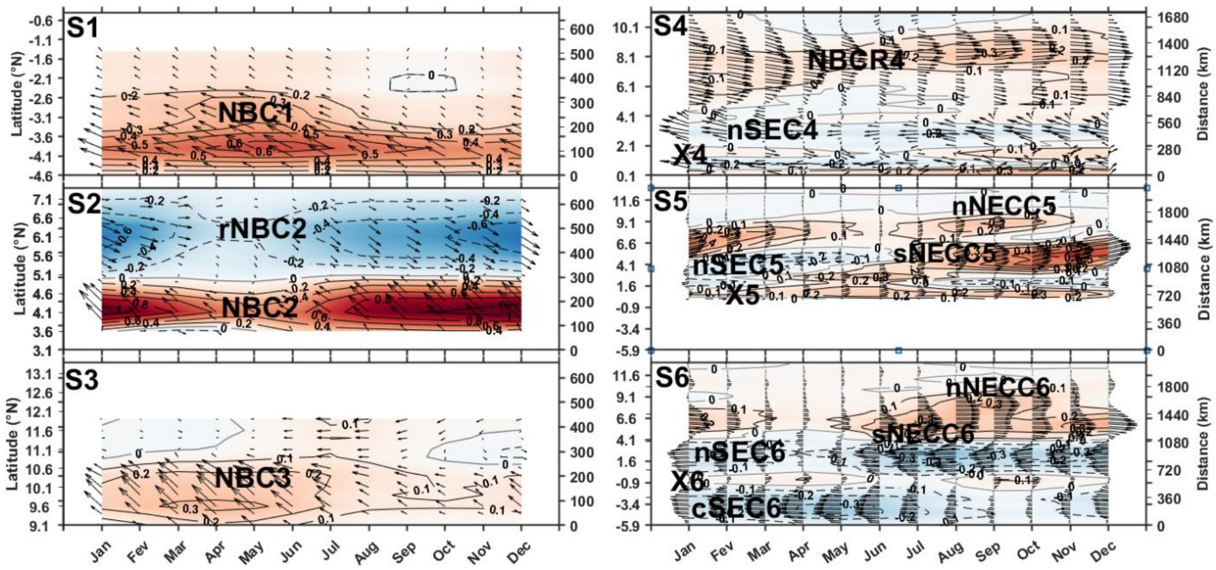


Figure 4. Average seasonal cycle obtained from Figure 3 (vectors of the currents are superimposed on the contour of their amplitude in m s^{-1}). On the right sides of each subplots, the distances from the southernmost point (in km) are indicated.

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). Here below is the final Fig. 4:



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.