Response to the reviews for

"Dependency of simulated tropical Atlantic current variability on the wind forcing"

by Kristin Burmeister, Franziska U. Schwarzkopf, Willi Rath, Arne Biastoch, Peter Brandt, Joke F. Lübbecke, and Mark Inall

We thank all reviewers for the constructive comments. We edited the text accordingly. Additionally, we changed the colour of the ship sections in Fig.1 and added labels to Figure 8. Figure A1 in the appendix is new and was added to assess the applicability of the Sverdrup balance in the tropical Atlantic as a result of main comment three from Reviewer 2.

Detailed responses are found below. The comments by the reviewers are shown in black, our responses are given in red.

Review of "Dependency of simulated tropical Atlantic current variability on the wind forcing" submitted for Ocean Science by Kristin Burmeister, Franziska U. Schwarzkopf, Willi Rath, Arne Biastoch, Peter Brandt, Joke F. Lübbecke, and Mark Inall (egusphere-2023-1433)

This paper investigates wind-driven variability of upper layer currents in the tropical Atlantic Ocean by comparing two simulations with a high-resolution ocean circulation model forced by two different atmospheric products provided for ocean-climate modeling. Long-term mean states are compared first, then seasonal cycle and long-term variability including trends are compared. Observational results are also used to validate the model where possible.

Results presented would be very useful for enhancing our comprehensive understanding of mean state and variability of upper layer currents in the tropical Atlantic Ocean. Methods used are appropriate, though they may not be necessarily novel. Publication would be recommended after some revisions.

Major points.

It would be very helpful for readers if the key drivers, all of which should not be necessarily wind-driven, for currents discussed in the paper are summarized in the early part of the manuscript. For example, the easterly wind, the Ekman divergence, and the meridional gradient of Sverdrup stream function for EUC.

Thank you for this suggestion. We added a few sentences to better highlight links between the easterly winds along the equator and the EUC and the equatorial Ekman divergence and the zonal flow field (L36-37, L41-45, L63-65, L368-383). We also added a few sentences about the link between the difference of the Sverdrup stream function at different latitudes and the zonal flow in the Data and Method section under "Sverdrup Balance" (L260-265).

Specific points.

L7,69,366 etc.: It would be helpful where "the upwelling regions of the eastern tropical North Atlantic", which is referred to many times in the manuscript, specifically represent is indicated somewhere in the manuscript. Figure 1c would be one of candidates.

Thank you for this suggestion. Figure 1 is already very busy. Instead, we added a sentence to explain where the upwelling regions are located in the tropical Atlantic (L40-41).

L43: Does the Ekman transport diverge or converge south of the ITCZ?

Thank you for catching this. Ekman convergence occurs just south of the ITCZ and divergence occurs north of the ITCZ. Under the ITCZ there is the eastward flowing geostrophic NECC. We edited the text accordingly (L55-58).

L52–53: It would be worth mentioning that there are some resemblances of the structure of the zonal currents between the equatorial Atlantic and Pacific, as authors cited many papers that treated the tropical Pacific Ocean later in this paragraph.

Thank you for this suggestion. We added a sentence to the paragraph accordingly (L74-76).

L92: This is a nice approach, but it would be appropriate to describe specifically how the time gap was filled between the CORE simulation and observations somewhere in the manuscript.

We are sorry that this sentence caused confusion. What we meant was that the simulation forced by JRA55-do allows for a direct comparison between model and observations which is not possible for simulations forced by CORE. We edited the sentence accordingly (L110-111).

L179: To what is the EUC transport reconstruction using the mooring compared?

It is compared to the transport derived from the ship sections. We edited the sentence for clarity (L205-207).

L204: Are there any known reason for the differences found among phase speeds of the first baroclinic mode?

Thank you for highlighting. We found an error in our calculation. The model output was not interpolated to a sufficient vertical resolution before calculating N^2 which led to an erroneous mode decomposition. We corrected the text (L231-232) and table 2 accordingly (here table 1).

Table 1: Result for gravity waves speeds in m/s for first five baroclinic modes of the gravest basin mode derived from the corrected N^2 profiles. Model and observations agree well with each other for all modes.

	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5
Obs	2.51	1.40	0.98	0.76	0.57
JRA	2.53	1.43	1.05	0.81	0.58
CORE	2.51	1.42	1.04	0.80	0.57

L365: It would be nice to show that the JRA55 wind forcing actually captures fine structures that force NEUC variability.

Sorry if we did not articulate us clearly. JRA55 resolves fine wind stress curl features which are not present in CORE which is shown in Fig. 3. CORE shows large-scale high amplitudes in the annual cycle of the wind stress curl above the eastern upwelling regions (Fig. 3f) which are not present in JRA. The latter shows much finer local structures (Fig. 3 e). We added a reference to the figure accordingly (L437).

L406–408, 577–578: Are only first two baroclinic modes used for the harmonic analysis shown in Figures 4 and 5? If so, please be specific about this.

In Figure 4 and 5 we only fit harmonic annual and semi-annual cycles to the data. No mode decomposition is performed here. These are presented in Fig. 6 and Fig. A2.

L412: Since long-term trends are treated here, it would be good to discuss why trends are relevant or whether any issues have been raised in relation to global warming.

Thank you for the suggestion. We added two sentences in the text (L 478-479).

L543: “This agrees with the weakening easterly winds along the equator.” … What does "this" point to? Should "weakening" be replaced with "trend of"? Or should “in JRA” be appended at the end of this sentence?

Thank you for highlighting that this section was not easy to follow. We edited the entire paragraph for clarity. (L635-639)

Technical points.

L62,63: Please give definition for NBUC and NBC.

Added. (L80-83)

L95: It would be more appropriate to cite Large and Yeager (2009) for introducing the CORE v2 dataset.

Thank you for highlighting. We edited the reference accordingly. (L146)

L121: well-establish ---> well-established

Changed. (L143)

L124: relative ---> relatively

Changed. (L147)

L129,757: It would be appropriate to cite Kobayashi et al. (2015; JMSJ) for introducing JRA-55.

Thank you for highlighting. We edited the reference accordingly. (L153)

L136: I would suggest something like, “Meridional ship sections are taken between 21°W and 28°W for velocity (31 sections) and hydrography and oxygen (22 sections) between 2000 and 2018”.

Thank you for this suggestion. We edited the text accordingly. (L159-163)

Table 1, L157: It would be needed to indicate that Z_u and Z_l are determined by the depths of specific values of potential density.

Thank you for pointing this out. We edited the text and caption of Table 1 accordingly.

L246: establish ---> established

Changed. (L280)

L274: extend ---> extent

Changed. (L310)

L275: reasonable ---> reasonably

Changed. (L312)

L276: The transports of currents north of the equator from the two simulations diverge…

Changed. (L313-314)

L296: 2°S and 2°S ---> 2°S and 2°N?

Changed. (L370)

L344–345: Are only eastward components integrated? If so, please notify it.

Yes, we integrate over eastward velocities as stated in L414-416: “To compare transport from model output and moored observations at 23°W, we calculated the transport for the EUC and NEUC from model output as integral of eastward velocities in the respective box” as well as in the methodology section.

L345: 1°12’S-1°12’N

Changed. (L416)

L345: Furthermore

Changed. (L416)

L376: force ---> forced

Changed. (L449)

L389: created ---> create

Changed. (L462)

L421: extent ---> extend

The whole paragraph was edited for clarity. (L477-508)

L439–440: It would be helpful if what is done here is explained using equations (e.g., $U = \Psi_N - \Psi_S$).

Thank you for this suggestion. We added a formula in the Data and Method section (L260-265) and referenced it in the text accordingly (L348).

L447,481: anomalous ---> anomalously

Changed. (L545)

L476: we find significant negative trends in current transport east of ~30°W in JRA_{sim}.

Changed. (L564)

L480: west of ---> east of (?)

Thanks for highlighting. Edited paragraph for clarity. (L566-L584)

L526–527: despite the distinct inter-simulation discrepancies of the NECC on multidecadal timescales, especially after year 2000.

Changed. (L617-618)

L564: wester ---> western

Changed. (L631)

L573: asses ---> assess

Changed to “To investigate…”. (L667)

L605: strength the ---> strength and the

Changed. (L715)

Figure 2 (the last line of the cation): as well as

Changed.

Figure 3: Is the phase given in month of the year when zonal wind stress/wind stress curl is maximum?

Yes, we added a sentence to the caption.

Figure 8: Please add labels *a* through *l* to panels.

Changed.

Figure 11 (caption, the line above the bottom): different ---> difference

Changed.

Figure A5: wind stress curl (above) and Sverdrup transport (below)

Changed.

L784: Perez et al. (2021) … Remove abstract.

Changed.

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