RESPONSE TO REVIEWER'S COMMENT (RC2)

for the manuscript "*River discharge impacts coastal Southeastern Tropical Atlantic sea surface temperature and circulation: a model-based analysis*" by Aroucha et al., submitted to *Ocean Science.*

We thank the reviewers for their thorough evaluation of our manuscript and their suggestions. Below, we provide a detailed response to all reviewer's queries.

To address their comments, we have revised all six figures in the main manuscript and added two new figures to the Supplemental Material. Consequently, the order and numbering of supplementary figures might also have changed. In the "TrackedChanges" file you can see all the modifications made and the "Main" file represents the final revised paper with the changes inserted.

References cited in this document are included at the end. Responses to individual comments are provided below, with specific references to the corresponding lines and sections in the revised manuscript. For clarity, our responses are highlighted in blue font throughout this response letter.

Anonymous Referee #2 (RC2)

Review of "River discharge impacts coastal Southeastern Tropical Atlantic sea surface temperature and circulation: a model-based analysis"

General comments

Understanding sea surface temperature (SST) and circulation in the southeastern tropical Atlantic is crucial for understanding upwelling dynamics, air-sea interactions, and other related processes. However, the limited availability of in-situ observations in this region has hindered a comprehensive understanding of these dynamics. The objectives of this study are therefore both timely and commendable. This study investigated the impact of river discharge on the mean state SST in coastal western Africa. Through modeling efforts, several scenarios and experiments were conducted to analyze the influence of large river outflows on SST and geostrophic flow in the region. The results indicate that river outflows generate a halosteric effect in the water column, leading to an increase in sea surface height (SSH) and inducing geostrophic circulation in the surface ocean. The resulting SSH gradient drives upwelling and downwelling processes, along with alongshore advection, which collectively alter SST. The paper is well-written, and the analyses are comprehensive, effectively addressing the research questions. However, the following recommendations should be considered for revision prior to acceptance and publication

Specific comments

1. L57: does the barrier layer not strengthen the vertical temperature gradient, hence reducing the impact of vertical mixing?

R. Thanks for the question. The barrier layer weakens the vertical temperature gradient between the mixed-layer and the waters below it. With a barrier layer (Figure R1 below, right plot), the mixed-layer (in this situation defined by a change in density rather than a temperature change) sits within the isothermal layer depth. Therefore, since the temperatures of waters within the isothermal layer are almost constant, the vertical temperature gradient is weakened in such cases.

The weakening of the vertical temperature (dT/dz) is then proportional to a reduction in the turbulent heat flux below the mixed-layer (J_h), which is defined as $J_H = - dT/dz*K_\rho$ (e.g. Hummels et al. (2020) and Körner et al. (2023)).

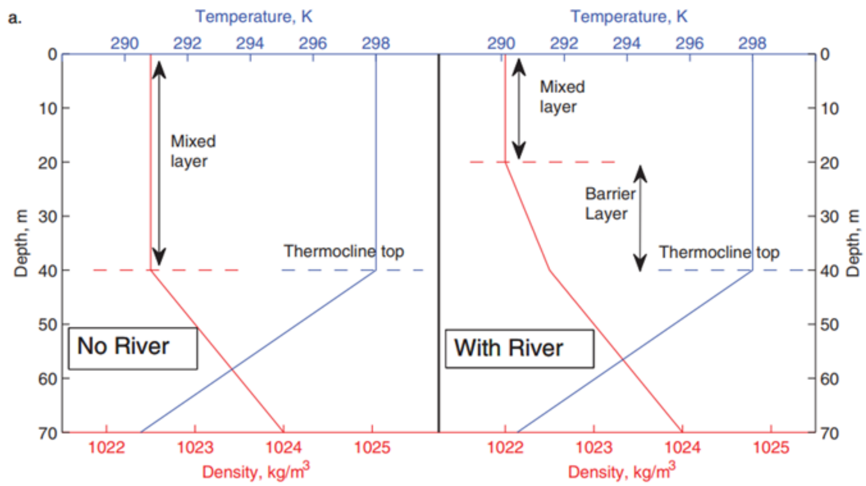

Figure R1. *A schematic view of a river-induced BL: the mixed layer is shallowed, whilst the top of the thermocline remains constant. Horizontal lines depict the bottom of the density and temperature mixed layers. Quantitative values and profile shapes are for illustration only. From White and Toumi (2014), Figure 8(a).*

2. L62: why averaging from surface to 50m depth?

R. We believe this comment refers to L.162 instead of L.62. Thanks for the question. We average the squared Brunt-Väisäla frequency values from the surface to 50m to depict a spatial view of the changes in stratification in the SETA. Since the MLD in this region is usually shallower than 50m (Körner et al., 2023; Aroucha et al., 2024), we believe that averaging until this depth well-captures the stratification shifts generated by the freshwater discharge in a 2D field. We have added this information in the main text, from L.164 to L.166.

3. L201-225 and Figure 1. It may be helpful to the reader to include the reasons for the biases here. Mainly, what account for the differences? Comment on the fact that the satellite product measures skin temperature while for the model, "surface" temperature is at 3m.

R. Thanks for pointing that out! From paragraphs 2 to 5 in Sect. 4 (Conclusions and Discussion) we extensively discuss the observed biases not only in the SST and SSS model data mean state, but also in its variability and the U, V, and CRD fields. We indeed mention the skin measurements compared against the 3m model "surface" temperature, but only in terms of SSS. This comment is now added also to the SST biases discussion in paragraph 2 of Sect. 4, from L.504 to L.506.

4. L304: The vectors on these plots are hard to see. Please refine.

R. Thank you! Following what was pointed out by Reviewer #1 in their Major Comment 2, we increased the arrow length and size, also changing the vector scale. We hope that the vectors in the new Figure 3 are now clearly visible.

Technical corrections

1. L31: The “West African” description is a bit confusing. Yes, its on the western part of Africa, but “West Africa” typically refers to the geo-political description.

R. Thank you for this helpful comment. Indeed, West Africa seems to be referring to the geopolitical description. To avoid this and be more precise in defining our area, we now refer to our region of interest as the southwestern African coast. You can find this new denomination throughout the paper.

2. L122: spell out NOAA

R.Done. You can find NOAA spelled out in L.126-127.

3. L127: “of bias-corrected SSS”

R. Thanks! Now corrected. See L. 131.

4. L132: the spell out of NEMO should come earlier, in L91

R. Indeed! Thank you. You can find NEMO spelled out in L.96-97 now.

5. L139: Congo River discharge has earlier been abbreviated to CRD. Please maintain consistency.

R. Thank you for pointing that out. Now Congo River discharge is abbreviated in L.36 and referred to as CRD throughout the text.

References cited in this document

Aroucha, L. C., Lübbecke, J. F., Körner, M., Imbol Koungue, R. A., and Awo, F. M.: The Influence of Freshwater Input on the Evolution of the 1995 Benguela Niño, JGR Oceans, 129, e2023JC020241, https://doi.org/10.1029/2023JC020241, 2024.

Hummels, R., Dengler, M., Rath, W. et al. Surface cooling caused by rare but intense near-inertial wave induced mixing in the tropical Atlantic. Nat Commun 11, 3829 (2020). https://doi.org/10.1038/s41467-020-17601-x

Körner, M., Brandt, P., and Dengler, M.: Seasonal cycle of sea surface temperature in the tropical Angolan Upwelling System, Ocean Sci., 19, 121–139, https://doi.org/10.5194/os-19-121-2023, 2023.

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