We warmly thank Javier Zavala-Garay for the time and attention devoted to our paper, and for those positive and constructive comments. We have carefully considered all those comments and suggestions in the revised version of our manuscript. In what follows, our answers and modifications are highlighted in blue. Page and line numbers refer to the highlighted version of the revised manuscript.

General comments

This manuscript evaluates the role of the background circulation, tides, and rivers on the South Vietnam Upwelling (SVU) system during the summer of 2018. The methodology and analysis is well though and convincing evidence is presented supporting that:

1. Wind forcing is the leading mechanism explaining the chronology of the upwelling in the 4 areas studied

2. The upwelling during the summer of 2018 in the Mekong shelf (MKU) is due to the convergence and divergence of currents (and the associated downwelling and upwelling), which are strongly influenced by topography and to a lesser extent by tides.

3. Tides increase the horizontal velocity gradient and hence the associated downwelling/upwelling

4. Tidal mixing enhances the upwelling by mixing of water column (a local effect) and by advecting water mixed upstream (a remote effect)

5. River discharge inhibits the development of MKU through enhanced stratification

- The only general comment/doubt I have is that this study focuses on a single year of intense upwelling (summer of 2018). I wonder how representative the identified mechanisms are for other years. The narrative in the conclusions seem to imply this is the case. The role of the tides should be the same for other years, but the details regarding the convergence/divergence of currents could be more variable, both in intensity and perhaps in localization, despite the fact that topographic steering plays an important role.
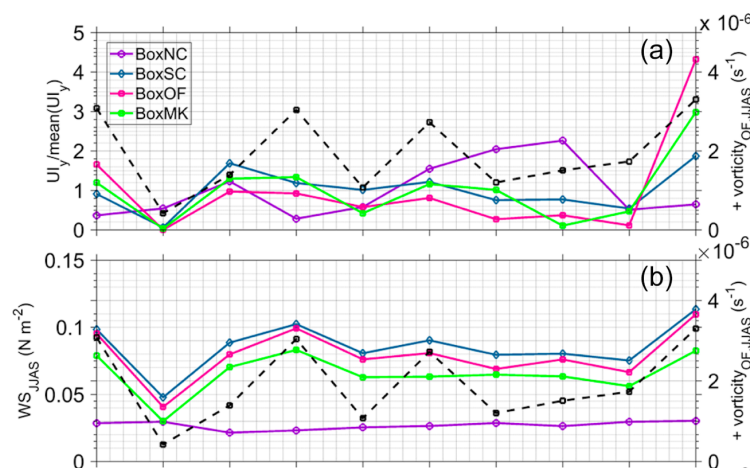

Figure A : Normalized yearly upwelling index (a) and JJAS averaged wind (b) between summers 2009 and 2018 in the LONG simulation. From To-Duy et al (2022, their Figure 13).

To-Duy et al. (2022) showed that wind over the SVU region was weaker than average during summer 2017, and so was the upwelling intensity (see Fig. A above, extracted from To-Duy et al. 2022). 2017 and 2018 therefore represent two cases representative of respectively weak and strong summer wind and upwelling. To discuss the representativeness of our conclusions obtained from the analysis of summer 2018, we thus examined the variability of the upwelling development over summer 2017, also

simulated in the FULL, NoTide and NoRiver 2-year ensembles. Figure B below shows for summers 2017 and 2018 the maps of summer SST in the three ensembles. Figure C shows the daily time series of wind over the SVU region, and of the ensemble average $UI_{d,box}$ and intrinsic variability $VI_{d,box}$ of daily upwelling intensity over its four areas of development. The correlation between wind over the SVU region and $UI_{d,box}$ in the FULL ensemble is provided in Table A.

Analysis of summer 2017 confirms the conclusions obtained from the analysis of summer 2018 :
- The intraseasonal chronology of upwelling intensity for OFU, SCU and MKU is primarily driven by wind (Fig. Ca,b,d,h), with highly significant correlations (at more than 99%) between $UI_{d,box}$ and wind for both summers 2017 and 2018 (between 0.55 and 0.68, see Table A).
- The intraseasonal variability of upwelling intensity of NCU is not driven by wind (see Fig. Ca,f and the not significant correlations between $UI_{d,box}$ and wind for both summers 2017 and 2018, Table A). As for summer 2018, NCU only develops during summer 2017 at the beginning and end of summer, confirming our conclusion about the blocking role of the general circulation that prevails over the area during the core of summer.
- For both summers 2017 and 2018, the influence of OIV on upwelling intensity is very weak for MKU, weak for SCU, and stronger for OFU and NCU (Fig. Cc,e,g,i). The stronger influence of OIV on OFU and SCU in 2017 compared to 2018 is presumably related to smaller values of upwelling intensity (since VI is computed as the ratio between the ensemble standard deviation and average).
- As already observed for summer 2018, summer 2017 shows no significant impact of tides and rivers neither on ensemble average intensity nor on OIV of SCU, OFU and NCU (Fig. Be,f and Fig. Cb-g)
- Tides have a major role in MKU development both for 2017 and 2018, with no MKU developing at all in the NoTide ensemble for summer 2017 (Fig. Be and Ch), and rivers slightly reducing the upwelling intensity in the middle of summer.

Figure D below moreover shows the yearly upwelling location, materialized by the UI_y 0.2°C iso-contours, and for summers 2017 and 2018 of the FULL ensemble and also for summers 2009-2018 of the LONG simulation evaluated and analysed by To-Duy et al. (2022). For summer 2018, the 10 members show rigorously the same location of MKU development. This area is strongly reduced for summer 2017. Over the 2009-2018 period, MKU always develops over the same core area, with a spatial extension varying with the strength of the upwelling. Following the comment of another reviewer, we also included in the paper a discussion about the role of topography, performing an additional simulation where the topography over the MKU shelf is smoothed (Section 4.1, page 12, lines 353-360, and Figure 7 of the revised manuscript). This change in topography results in a change of the southern limit of MKU extension. Those results confirm that the stability of the location of MKU development, indeed related to the influence of topography.

This further analysis of summer 2017 in our three ensembles and of the 2009-2018 simulation therefore suggests that our conclusions based on the detail analysis of summer 2018 regarding the mechanisms involved in the development and intraseasonal variability of SVU (wind, general circulation, intrinsic variability, tides, rivers and topography) over its four area of development, and in particular over the MKU region, are robust throughout the different years and associated atmospheric, oceanic and river conditions.

→ following this comment, we added those figures (Figures 2, 11,12) and a whole dedicated section (*Section 5, Representativeness of summer 2018,* page 16) in the revised version of our manuscript and modified the Introductioon (page 3, lines 110-111) and conclusion accordingly (page 17, lines 532-534).

Table A : correlation between the daily wind averaged over the whole SVU area and the ensemble average of UIy is provided in Table A in the FULL ensemble. Correlation significant at more than 99% (at less than 90%) are in bold (italics).

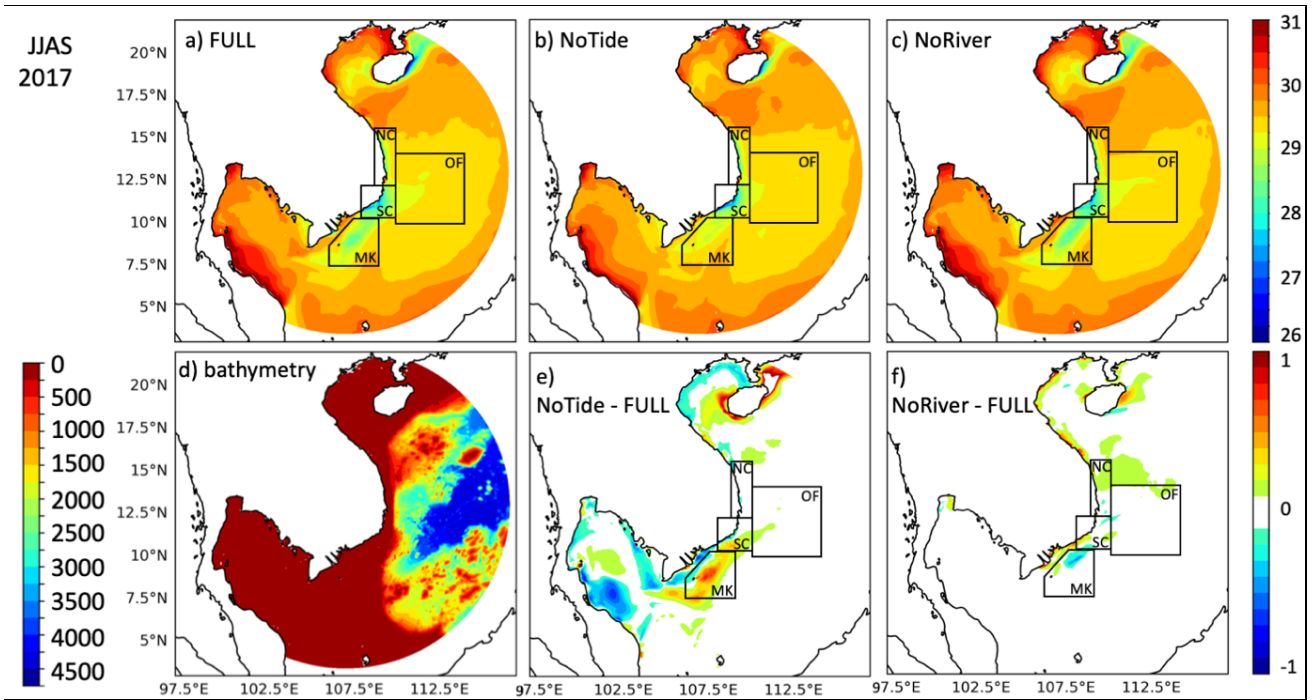|	SCU	OFU	NCU	MKU
Summer 2017	**0.594**	**0.554**	*-0.167*	**0.621**
Summer 2018	**0.596**	**0.604**	*-0.025*	**0.683**

Figure B : Ensemble average SST over June-September 2017 in the FULL (a), NoTide (b) and NoRiver (c) ensembles and difference between the NoTide (d) and NoRiver (f) and FULL ensembles (∘C). Panel d shows the bathymetry of the domain (m). Color bars for panels (a-c) and (e-f) are provided on the top and bottom right, and color bar for panel (d) on the bottom left.
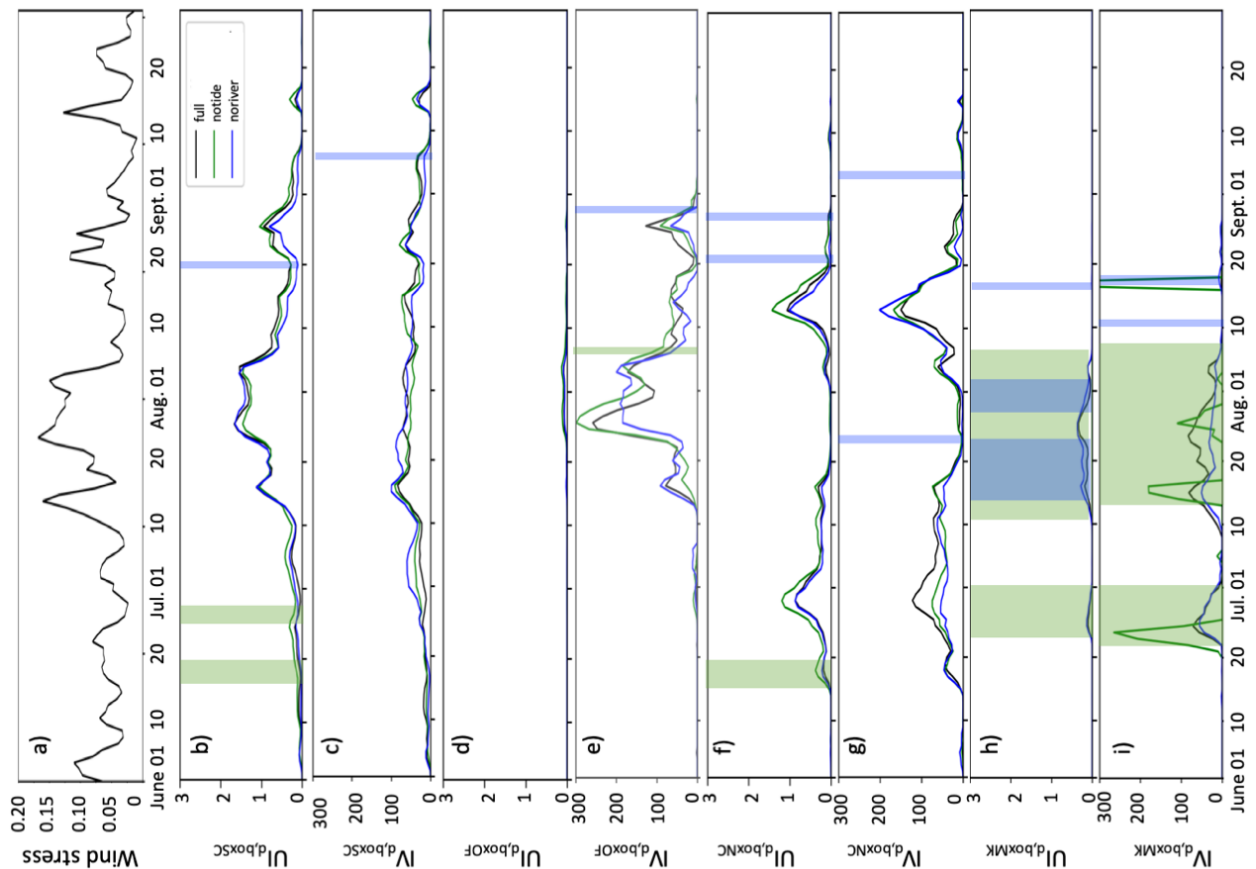

Figure C : Daily time series over summers 2017 of averaged wind stress (a, N.m−2) over the whole upwelling region (7.5-14°N, 106-114°E) and of the ensemble mean of $UI_{d,box}$ and of $IV_d(UI_{d,B})$ (∘C) for the FULL (black), NoTide (green) and NoRiver (blue) ensembles for NCU (b,c), SCU (d,e), OFU (f,g) and MKU (h,i). Shaded green and blue colors shows the areas where the difference between the reference FULL and sensitivity NoTide and NoRiver ensembles is statistically significant at more than 99%.
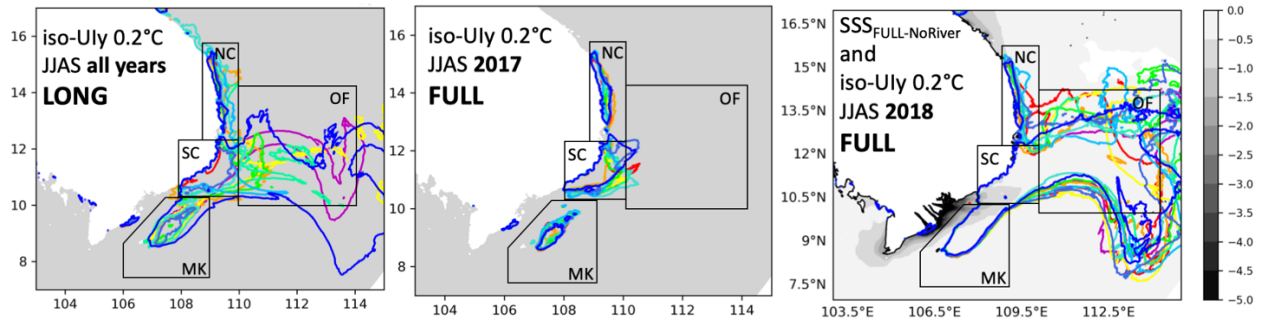
Figure D : isolines of 0.2°C of yearly upwelling index UIy for the ten summers (June-September) 2009 to 2018 in the LONG simulation (left), and for summer 2017 (middle) and 2018 (right) in the ten members of the FULL ensemble. The difference between ensemble average of summer sea surface salinity (SSS) in the FULL and NoRiver ensembles is also showed in the right panel to highlight the Mekong river plume position.

- I also think that providing some model validation could be useful. Is the upwelling well represented by the model when confronted by observations?. Is the MKU upwelling observed by the satellite SST products? If so, describing this could help the reader to assess how representative the mechanisms described here are.

The evaluation of the ability of the model to represent ocean dynamics and water masses from daily to interannual scales and from coastal to regional areas was demonstrated in details in the study of *To-Duy et al. (2022).* They compared a simulation performed over the period 2009-2018 with satellite datasets (sea surface temperature (OSTIA and JAXA), salinity (SMOS) and elevation (AVISO)) and with four in-situ datasets (temperature and salinity profiles of ARGO floats over 2009-2018, glider data over 2017 and CTD data during September 2018; SST and SSS from TSG data during summer 2014). In particular their high-resolution simulation, together and in agreement with a careful examination of available satellite and in situ data, showed for the first time the existence of MKU, and the ability of the model to represent it. Limitations associated with classically used gridded satellite data indeed strongly reduce the spatial observability of small coastal areas.

→We added a paragraph in the text to refer to the study of *To-Duy et al. (2022)* (Section 2.1, page 5, lines 128-134).

- One additional note: Fig. 9 nicely summarizes the findings described in the manuscript. Thank you!. However it seems to me that such Figure is not referenced in the manuscript (or maybe I missed it).

Indeed, thank you for pointing this out ! We refer to this figure in the revised manuscript (Conclusion, page 17, lines 533-534).

Specific comments

- P4,L17. It is mentioned that the simulation covers 2017-2018. However just the summer of 2018 seems to be analyzed. Why? Please clarify

We performed a first study about the South Vietnam Upwelling at the interannual scale over the period 2009-2018, published in *To-Duy et al. (2022).* This study showed that the upwelling was particularly strong during summer 2018, due to very strong southwest monsoon wind during this summer. Summer 2018 was therefore chosen as a case study by *Herrmann et al. (2023)*, and in the following manuscript. However, as pointed out by the reviewer, our ensemble simulations also cover the period 2017, which was a summer of weak upwelling for the four boxes in the 2009-2018 simulation of *To-Duy et al. (2022)*. We therefore examined summer 2017 to examine the robustness of our conclusions regarding the effects of tides and rivers on the upwelling strength and OIV over its four areas of development, and

regarding the functioning of MKU. This is explained in details in the answer to the first general comment above.

- P4: since Kz is reported later in the analysis of the sensitivity to river discharge experiment, it could be good to mention what vertical mixing parameterization is used in the model

Vertical mixing is parameterized according to the k-epsilon turbulence closure scheme (*Rodi, 1987*). This was added in the revised manuscript (Section 2.1, page 4, lines 116-117).

- P5: why MKU does not include the coast?

The four upwelling boxes were defined by *To Duy et al. (2022)* based on the spatial distribution of SST and upwelling spatial index UI_{JJAS}, and with the aim to fully cover the upwelling development areas. We show in Fig. D above the 0.2°C isoline of UI_{JJAS} for the 10 summers (JJAS) of the 2009-2018 simulation examined by *To Duy et al. (2022),* and for the 10 members of summers 20187 and 2018 of the FULL ensemble. They confirm that MKU does not develop along the coast, but slightly off the Mekong delta coastline, and that the MKU box designed by *To Duy et al. (2022)* cover the upwelling development offshore the Mekong delta coastline. Note that we can see small coastal area of low SST at the Mekong mouth, but we excluded those small areas since our model ~1km resolution along the coast as well as the coarse prescription of river water temperature (28°C) may not be perfectly suited to represent the estuarine dynamics. One could include the coast but this would not change a lot the results given the very small size of those areas.

→ Following this comment, we added Figure 2 in the revised manuscript, and commented it in the revised manuscript (Section 2.3.1, page 6, lines 174-178).

- P7: in "SEJ and eddy dipole are well established in July-August, preventing NCU to develop, and much weaker at the beginning (June) and end (September) of summer, allowing NCU to develop." A similar effect is observed for the OIV, could you comment on this?

Herrmann et al. (2023) showed that NCU is first driven by the large scale summer circulation, that prevents or allows its development. When the cyclonic circulation off the NCU region related to the summer dipole and SEJ that prevails is well established, NCU can not develop. As a result, its chaotic variability is weak: it is weak whatever the member of the ensemble. Conversely, when the cyclonic circulation is weak, at the beginning and end of summer, NCU development is allowed depending on the organization of small scale circulation over the NCU area, which is strongly chaotic. NCU OIV is therefore strong during the periods of allowed development, and weak during the periods of prevented development, explaining the similar chronology of NCU intensity and OIV.

→ We added a few lines in the revised manuscript to comment this (Section 3.1, page 8, lines 224-232).

- In "Strong mid-July and mid-August wind peaks indeed induce peaks of upwelling intensity for MKU, SCU and OFU in the FULL ensemble analyzed in this previous study, while NCU does not develop during the core of the summer but in late June and late August (Fig. 2)." Could you comment on how different is the wind stress for other years?. That is, I wonder how representative these results are for other years.

To-Duy et al. (2022) already showed from the analysis of their 2009-2018 simulation that the development of NCU is inhibited or favored depending on the circulation that prevails over BoxNC. They showed that the NCU is inhibited when alongshore currents, either southward or northward and resulting from two opposite situations in terms of wind and offshore circulation, prevail over BoxNC. Southward currents are associated with the general cyclonic circulation that prevails offshore BoxNC during summers of strong wind over the SVU region, as for summer 2018, while northward alongshore currents can only develop during years of weak wind. *To-Duy et al. (2022)* showed that NCU can only develop during periods of weak general circulation, at the beginning and end of summer or during summers of very weak wind, allowing the circulation prevailing over BoxNC, which is highly chaotic, to be offshore oriented. The analysis of summer 2017 detailed above (Fig. Cf) further confirms those conclusions, showing a development of NCU at the beginning and end of summer and no NCU during the core of summer.

→ We added a few lines in the revised manuscript to comment this (Section 3.1, page 8, lines 224-232 and also Section 5, page 16, line 486-488).

- P7: In "The effect of river discharge on the intrinsic variability of in MK is much weaker :" This is a bit counter-intuitive. River discharge will introduce strong buoyancy gradients in the mixed layer, which promote the development of submesoscale variability. Is this because BoxMK excludes the coastal region?

We indeed explained above that the area of upwelling development over the shelf does not reach the very coastal region, which is therefore not included in BoxMK. We show in Fig. D above the difference of sea surface salinity (SSS) averaged over JJAS in the FULL and NoRiver simulation: the area where this difference is significant (exceeding ~1 psu) highlights the area of influence of the Mekong River plume. Fig. D indeed shows that the plume hardly reaches the MKU box, only covering its northwestern corner, as already shown for July 31st in Fig. 10a of the manuscript. Finally river discharge therefore only affects the vertical stratification over a small area of boxMK (near point G, Fig. 10a,c). The area where strong buoyancy gradients could develop and enhance chaotic variability is thus not included in BoxMK, or very small, explaining that river discharge do not have a significant influence on MKU OIV.

→ We added a few lines in the revised manuscript to comment this (Section 4.3, page 15, lines 471-476 and Fig. 10ac).

- P8: In " We take M17, i.e. the simulation where both the small and large scale states are given by conditions of January 2017 of the PSY4QV3R1 analysis", Is there any validation of the model solution over this period? At least for the SST, SLA and maybe SSS … If it was reported previously, it would be good to reference that.

See answer above for the general comment : we added a paragraph in the text to refer to the study of *To-Duy et al. (2022)* who carefully compared the model with satellite SST, SLA and SSS data as well as in-situ T and S profiles, from the intraseasonal to the interannual scales (Section 2.1, page 5, lines 128-134).

- P9: In "the edge of the continental slope, this barotropic warm northeastward current meets a cold bottom northwestward current that flows from the open area towards the coast (Figs. 3d,4d)" Is this really at the edge of the continental slope?

Indeed, this is more generally on the shelf slope. The position of this convergence is driven by the topography, as suggested by an analysis done to answer a comment of the other reviewer about the influence of topography.

→ We changed "the edge of the continental slope" by "on the shelf slope" in the text (Section 4.1, page, line) and added a whole paragraph about the influence of topography (Section 4.1, page 11, line 335).

- P13: In "This stratification weakening makes the water column easier to mix vertically, facilitating the tidal vertical mixing, which is the main contributor to MKU in this area and during the transition period, as explained above" Is there any extra contribution due to wind forced coastal upwelling in the NoRiver case?

One could indeed expect that the weaker stratification along the coast could indeed favor the coastal Ekman transport. Examining carefully the SST difference between FULL and NoRiver over the MKU region, there is however no significant intensification of MKU that could be induced by wind forced upwelling intensification (Fig. Bf), neither for 2017 nor for 2018. The river effect on the stratification is therefore not sufficient at the coast to significantly enhance the Ekman transport driven upwelling.

→ We added a few lines in the revised manuscript to comment this (Section 4.3, page 15, line 471-476)

- P13: In "Three sensitivity", the FULL experiment is the reference state. Therefore two sensitivity experiments were performed (NoTide and NoRiver).

Indeed ! This has been modified accordingly in the Introduction (page 4, lines 104 and 118) and conclusion (page 16, line 504).

Technical corrections

Note: English is not my first language. Therefore non-typo corrections are just suggestions to be taken with a (huge) grain of salt.

We are not English native speakers ourselves. In order to improve our writing and to answer the comments below, we therefore also asked for the advice of an English native speaker colleague.

- P1: Maybe change "investigating" by "investigates"?

This has been modified accordingly (page 1, line 5).

- P2: In "∼ 14°E", is this 14 deg N?

This has been corrected (page 2, line 30).

- P2, L56: change "and" by "are"?

This has been corrected (page 2, line 57).

- P3,L67: Change "tidal" by "the tidal"?

This has been corrected (page 3, line 68).

- P4: Maybe change "ensemblist" by "probabilistic"?

This has been modified accordingly (page 4, line 101).

- P4:L108: Change "refsec:conclusion" by 5.

This has been corrected (page 4, line 111).

- P7: "n :" There are numerous spaces before punctuation colons. I wonder if this was just an effect of the pdf rendering …

This has been corrected throughout the manuscript.

- P11: Change "°C" by "deg E"

This has been corrected (page 14, line 416).

- P12: In "tidal mixing is a major factor of MKU maintaining." Maybe "on the maintenance of MKU"?

We replaced by "the contribution of the horizontal circulation gradient to MKU is therefore strongly weakened, and tidal mixing is a major factor in maintaining MKU" (page 13, line 434).

- P12, L360: "in" by "on"?

Apparently "in" seems correct.

- P12: In "fresh hence light .." maybe "fresher (and hence lighter) water .."`

This has been modified accordingly (page 14, line 456).

References

Herrmann, M., To Duy, T., and Estournel, C.: Intraseasonal variability of the South Vietnam upwelling, South China Sea: influence of atmospheric forcing and ocean intrinsic variability, Ocean Science, 19, 453–467, https://doi.org/10.5194/os-19-453-2023, 2023.

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To Duy, T., Herrmann, M., Estournel, C., Marsaleix, P., Duhaut, T., Bui Hong, L., and Trinh Bich, N.: The role of wind, mesoscale dynamics, and coastal circulation in the interannual variability of the South Vietnam Upwelling, South China Sea – answers from a high-resolution ocean model, Ocean Science, 18, 1131–1161, https://doi.org/10.5194/os-18-1131-2022, 2022.