Estimating oceanic physics-driven vertical velocities in a wind-influenced coastal environment

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Reply to referee #1: Diego Cortés-Morales

We would first like to thank you for the time you spent reading our manuscript and your constructive comments. Before answering, please note that we decided to add the latest JULIO time series (from July 12, 2023 to May 22, 2024) to our revised manuscript as we obtained the data during the review process. We think that it brings valuable information on our work as it adds ~20% of data compared to the previous dataset in the original version of the paper.
Following your suggestions, we have modified our manuscript and answered your comments.

Specific comments:

The manuscript repeatedly states that JULIO has measured vertical velocities "since 2012". This phrasing is misleading because the dataset is discontinuous, with a gap between 2015 and 2020 (see Table 1 and Figure 10). This limitation should be explicitly acknowledged in the abstract and the rest of the manuscript, and do not consider the analysis of more than a decade of data.
You are absolutely right: we made it more obvious in different parts of the text.
New lines 6-7: " JULIO provides Eulerian measurements of three-dimensional current velocities over two time-periods: 2012-2015, and since 2020."
New lines 123-124: "The JULIO (JUdicious Location for Intrusion Observation) mooring ADCP provides in situ time"
New lines 151-152: "The observations (interrupted by yearly maintenance and trawling incidents) began in 2012 and were suspended from 2015 to 2020."
New line 433: "Vertical velocities (W) are measured with the JULIO moored-ADCP over the period 2012-2015 and since 2020."

The comparison between JULIO ADCP, FF-ADCP and VVP is presented as a central result, but the conclusions are too general and not the core objective of this paper. The conditions for the comparison should be highlighted and clarified, including the choice of periods used for JULIO ADCP and FF-ADCP of around 2 hours while VVP data is limited to 17 minutes. Could more detailed insights be extracted from this intercomparison? For example, how each method captures upward vs. downward velocities, or how the sign of *w* evolves in time?
The way the results were presented was indeed unclear and was changed thanks to your suggestions. The main result from this comparison is that the order of magnitude and variability are consistent between these measurements. Hence no bias is seen for each measurement compared to the others. Nonetheless, the different methods capture different time properties. We have added a figure (Fig. 2 bottom) to illustrate this point.
In situ measurements are highly dependent on meteorological conditions, as well as other time or strategy constraints. In our case, only one cast of VVP was possible because of time constraints of its deployment: 15min at the surface before diving (to be able to have the GPS signal), then diving at 80 meters at +/- 10 cm/s lasting about 15 mn and back up (measurement phase) during ~17 minutes. Hence the measurements of JULIO ADCP (every ½ hour) are chosen to be the closest available to this single VVP cast. As for the FF-ADCP casts, 1 hour of mission was planned during the VVP cast.

The manuscript does not discuss the intrinsic measurement errors of the instrument. What are the uncertainties associated with the velocity estimates (e.g. Figure 3)? Given the small magnitude of the measured vertical velocities in the intercomparison, this information is essential.

The error measurement of vertical velocities combines the instrumental and the methodological errors. In our case, the errors are the following:

- Intrinsic ADCP error due to hardware which includes (for our ADCP 300 kHz) 0.5% of the measured value and a quadratic addition of a conservative value of +/- 5 mm/s, both given by the manufacturer.
- Methodological ADCP, depending on the deployment characteristics: number of bins (cell size), number of pings. This conservative error (private communication with RDI) is +/- 5 mm/s, added quadratically

The combined error gives us the absolute instrument error of +/- 7mm/s.

The errors coming from the biological identification can also influence the average W calculated in each specific event. For instance, we computed W averaged over U_{2022} for both smaller and bigger boxes, giving a difference of 2.8 mm/s between these two extremes (new lines: 314-316).

The manuscript is somewhat disorganised. Very specific event analyses are introduced early, without giving a proper explanation of this choice, while a broader overview of the JULIO time series only appears near the end (Figure 10). A more logical structure would be to first present the general time series (Figure 10 or even Figure S18) after Figure 3 and then focus on the specific events.
Indeed the manuscript lacked fluidity. In the new version, after the comparison between the three methods to place a context around the values obtained at JULIO, we give an inter annual overview of all vertical velocities combined (physics-driven and biological-induced) to show the phenomena that can be observed there. Then we explain and apply our biology filtering method, showing a specific example before applying it to all time series. Then we present our identification method for upwelling/downwelling events and focus on four specific examples.

Moreover, as you recommended, we chose to keep only the depth averaged version of Fig. 10 (now Fig. 7), and not the time-depth averaged of the initial version, hence presenting more general time series.

The annual probability distributions in Figure 3 should be interpreted with caution. According with Table 1 and Figure 10, only 2021 and 2022 provide complete annual coverage, so interannual comparison are likely dominated by sampling differences and seasonality of the vertical flow. The statement on lines 234 and 235: “boxplots highlight that 50% of the values are between -5 and 5x10^(-3) m s-1” should be framed as an order of magnitude, not a strict threshold. The manuscript should also clarify that the variability in the number of observations is due to short time series than a different sampling frequency (this is mentioned only later, on Line 316 but should be brought to the reader much earlier).
The sampling context was not explicitly reminded to the reader when the distributions were analyzed. We changed our descriptions/statements accordingly:
Line 252-253: “Annual sampling varies from one year to another regarding the duration, the number of months, and the sampled seasons.”
Line 256-257: “Nonetheless, one should note that, although the sampling frequency remains the same, the number of months sampled varies depending on the year.”

The criteria for selecting the upwelling and downwelling events, as well as the period used for the identification (Line 302) are nor well justified. The chosen events do not appear to be the most intense in Figure 10. For example, in U2022, why do the authors chose two days for the consideration of the upwelling? Do the authors use the wind velocity to identify these events? If so, how sensitive are the results to these choices? For U2012, the extreme wind event above 15 m s-1 is shorter than for 2022

and lasts less than 2 days. I don't understand the choosing of the window because it starts after a 15 m s-1 measurement, but it is not contained in the considered period. Without a statistical analysis of the entire time series, the representativeness of these four events is questionable, and the conclusions should not be general.

As mentioned in lines 415 to 417, different criteria can be used to determine an upwelling or downwelling duration. It is true that our choice was not clearly explained as well as our identification method (now detailed from line 298 to 305). For the example of U2012, we chose a window that matched intense wind (above 10 m/s as a threshold) and the W response (intense and positive values). For each example presented in the paper, we focused rather on the duration of intense W than the duration of the wind gust: for example, D2014 was triggered by a wind gust that did not last the entire downwelling.

The average upwelling and downwelling values reported in the abstract and the conclusions are extremely sensitive to the chosen filter parameters and averaging window. Moreover, they are based on a very small subset of events (one single event of 2 days and 12 hours respectively) relative to 5-year dataset.

That is true. We decided to keep a no-time averaged version of Fig. 10 (now Fig. 7) to exhibit the occurrences of strong W and our studied events. We also precise in the text that 12 events have been detected with our detailed identification method and four of them have been chosen as examples (new lines 306 & 435). We chose the four events detailed in the paper as illustrative examples for their good agreement with satellite observations.

Technical corrections:

The manuscript requires careful proofreading, especially regarding comma usage. Below are some specific corrections and suggestions:

All these corrections and suggestions have been taken into account.

- Line 11: "associated with" (not "associated to")

New line: 11

- Line 12: Use consistent notation for vertical velocity, here you use lower-case w, but during the rest of the draft you refer as W.

Deleted.

- Line 12: "Hence," (add comma).

New line: 12

- Line13: "high-frequency"

Deleted.

- Lines 34 and 42: "of a few" (not "of few")

New lines: 35 & 44.

- Line 35: "allow estimating" instead of "allow to estimate"

New line: 37.

- Line 38: "Frajka-Williams et al. (2011) were"

New line: 40.

- Line 39: "Other 3-month" (not "Other 3-months")

New line: 41.

- Line 44: change "since decades" to "for decades"

New line: 45.

- Line 50: change "electro-magnetic" for "electromagnetic"

New line: 52.

- Line 50: Clarify whether APEX is an acronym?

Clarified line 52: "Using electromagnetic APEX (Autonomous Profiling EXplorer) floats"

- Line 61: change "ship mounted" for "ship-mounted"

New line: 63.

- Line 64: change “inter annual” for “interannual”

New line 66.

- Line 84: “downwelling and upwelling events” (not “downwellings and upwellings events”)

New line 85.

- Lines 94 and 196: Could you maintain the same format for coordinates?

We made sure to re-write every coordinates in the same order, and in decimal degrees.

- Line 97: change from "vertical velocities measurements” to “vertical velocity measurements”

Changed.

- Lines 100, 119, 270: “W was…, W is …, W was” W is referred as plural in the rest of the manuscript

Line 100 (new line 101): corrected to “were”

Line 119 (new line 126): “W is” the “is” is not for W but for “analysis”. The whole sentence is “Within the framework of these observations, a thorough analysis of the intensity and variability of W is conducted using the moored ADCP time series dataset.”

Line 270 (new line 310): “W was” refers to an upwelling here. The whole sentence here is “An upwelling (U2022) with intense positive W was detected at JULIO, after biology filtering, from April 1st to April 3rd 2022”

- Line 102: Add comma “Generally, W have very low intensities”

Changed.

- Line 112: change from “also impact” to “also impacts”

New line: 111.

- Line 116: Introduce the JULIO acronym at the first mention, not in line 135

Introduced in the abstract (line 5) and intro (line 123).

- Line 117: change “multiyears” to “multi-year”

Deleted.

- Line 117, title Table 1, 191 and 409: “time series” (not “time serie”)

New lines: 123, 202 and 395.

- Lines 122 – 24: No space before a question mark in English.

New lines 128-130.

- Line 127: Introduce the FF-ADCP acronym at the first mention

New line: 132.

- Line 144: Which is the sampling frequency of JULIO? I think it is written in line 230, can you put it here instead?

The sampling frequency of JULIO was explicited at line 143 (now 149) “Time series are obtained with a time resolution of half an hour and a vertical resolution (i.e. cell size) from 4 m to 2.5 m (Table 1).” We think it is important to keep it in the inter-comparison section too, as we insist on the differences of sampling between the three methods (new line 247).

- Line 150-157: Missing reference

New line: 162-163.

- Line 160: Justify parameter choices with references.

We chose to apply a rolling mean to obtain the EAA trend as the signal was too noisy to be exploitable. We didn’t want to take a larger window to avoid seasonal variability. The 15-day rolling mean was the optimized parameter for our study, sufficient to avoid noise and not too large to avoid seasonal changes.

- Line 164: Define “MIO”.

New line: 173-174.

- Lines 188 to 190: Missing commas before numbers?

New lines: 198-201.

- Figure 2: Could the authors thicken the dashed lines in JULIO and FF-ADCP panels? In the FF-ADCP case, I think that thickening the lines would improve the readability of the different colours. Clarify meaning of lines in caption (depth units, time periods, shading). Could you add also the time period of each methodology in the caption, will be easier for the reader than to search for it in the body text.

Changed for Fig. 2.

- Line 245: Remove double parenthesis in reference: "((Heywood, 1996))".

New line: 268.

- Line 247: Missing space in "(Fig.6 top panel)".

New line: 270.

- Figure 4 caption: There is not solid lines in the figure, do you mean dotted lines?

Indeed, we forgot to change our descriptions. The Fig. 4 caption has been changed.

- Line 252: remove space "value :"

Deleted.

- Figure 6 caption: Could you add the period of study as in Figure 4?

The caption has been changed.

- Line 260: Replace "penultimate panel" with "panel c)".

New line 283.

- Line 264: Could you add a reference? This affirmation is for the climatology. Is always constant during the year or it has a seasonal cycle?

Thanks for underlining it. It indeed has a seasonal cycle. The appropriate bibliography has been added (new line: 295-296).

- Line 266: Reference needed for the 15 m s-1 threshold

The wind threshold and its reference has been detailed in our upwelling/downwelling identification method (new line: 303).

- Line 275: Use American spelling "analyzed" consistently

New line: 320.

- Line 277: Add space in "(Fig.8)".

New line: 322.

- Line 284: I do not think that it is necessary to add <W_2012 >, if you do, please add it in the other cases <W_2022 >.

Indeed, we decided not to use this writing (new line 329).

- Figure 7. Improve colour contrast of the lines U2012 and U2022. Could you add the years 2012 and 2022 above each column as title? It would help with reading. Could you add letters to the panels in the figure to make it easier to refer to them in the text? Adding a horizontal line at 15 m s-1 wind panels could help to define better the average region.
- Figures 7 and 9. The authors are using a sequential colormap for a variable with positive and negative values. I recommend using a diverging colormap to improve readability and the understanding of the discussion and conclusions.

The Figures 7 and 9 (now 8 and 10) have been changed accordingly.

- Figure 10 caption: Clarify whether horizontal lines correspond to +- 5 mm s-1?

Figure 10 (now Fig. 7) caption has been changed.

- Figure 10: Ensure consistency between Figure 10 and Table 1 (dates for 2013–2014). Time series during 2013 and 2014 do not correspond with the dates of Table 1 (Time series 2). In the table is written 03-26-2013 as initial date, but the time series in Figure 10 show that the values start at the end of September 2013.

Thank you very much for pointing this. We corrected it.

- Line 321: Add missing space and remove dot: 15m.s−1

New line: 391.

- Line 324: Add missing units: 0 m s−1

New line: 296.

- Line 325: Add missing space: 5 x 10^(-3m s−1

New line: 288.

- Line 327: remove s in “exhibits”

New line: 344.

- Line 343: Consider citing Jacox et al. (2018) on coastal upwelling.

Thank you for this recommendation. Jacox is cited in new lines 407-408.

- Line 346: Missing r in “occurences”

New line: 412.

- Line 360: Justify choice of a two-month time series? Consider seasonal climatology

We centered the satellite time series on our events. The chosen window had to be large enough to observe variations or trends but not too large to avoid seasonal variations. Thus, we chose a two-month window for clarity.

- Line 371: Meridional component during D2014 event seems much more variable than for D2121 event. Maybe it is because of the colormap chosen does not allow for a clear view of positive and negative values as I mentioned above.

Thank you for the suggestion, indeed a diverging colormap allows us to better distinguish currents direction variations. Regarding the variability, D2014 matches intense positive meridional component and thus onshore current. The variability here seems to be more in intensity than in directions (except the two deepest layers). For D2021, not only the meridional component but the horizontal currents are more variable in directions and not in intensity: zonal component shifts direction during D2021 and meridional component shifts at the very beginning of the event.
We cleared the text in that way: new lines 369-370 “D2014 matches intense positive meridional component of current, hence onshore horizontal currents, while D2021 shows a strong variability in direction for horizontal currents within two days.”

- Line 391: Remove s in “works”

New line: 438.

- Lines 390-396: The authors should detail that they are talking about the four events analysed and only generalised to the entire period of study after demonstrating that they are representative events. Could you compute the correlation coefficient between wind velocity and vertical velocity?

A Pearson correlation has been performed between wind and intense W but we found a weak correlation, which is not surprising giving the fact that intense W exist without being related to strong wind events and upwelling or downwelling events.

- Line 401: remove s in “medians”

New line: 448.

- Line 405: missing s in “type”

New line: 452.