

Referee comment on “*A data-driven wind-to-current response function and application to Ocean surface current estimates*” 2025, Clément Ubelmann et al.

Submitted by Jack Reeves Eyre
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Overview

This manuscript presents an empirical method to calculate a response function of ocean surface current to near-surface wind. Such a function can then be used to estimate the surface current resulting from any arbitrary wind forcing. In this case the response function varies only with latitude and season, but is still able to capture a significant fraction of the current variation observed with drifting buoys.

The paper gives a convincing demonstration that the method serves the intended function. It is mostly well written, with high quality figures. Improvements can be made in the description of datasets used, and in the discussion of some concepts underlying the idea. I recommend publishing after minor revisions.

Major comments

Meaning of wind driven currents

My main scientific issue with this work is the implicit assumption that wind-driven currents means inertial oscillations forced stochastically by wind events. This is clearly a large part of current total variance, especially in mid- and high-latitudes, and is well captured by the method, as shown by the analysis. However, there are wind-driven current variations at diurnal and shorter time scales that the authors do not discuss, and that this method does not seem to capture very well. This is particularly true of diurnal and semidiurnal variations in the tropics (red line falls below blue line in Figure 5) but is also true at the small diurnal peak in drifter observations in Figure 4.

I do not think more analysis is needed to address this, but these phenomena, and related weaknesses in the method, should be discussed. A couple of concepts that could be mentioned in this light:

- Diurnal warm layers can create significant diurnal wind-forced current variations (e.g., Masich et al, 2021, Cherian et al. 2021, Reeves Eyre et al. 2024) that propagate to 15 m or below. Would adding stratification to the explanatory variables help capture this?
- Diurnal and semidiurnal wind stress variations (e.g., Ueyema and Deser, 2008) could contribute to current variability. However, ERA5 does not use time varying SST, so may

not capture these wind stress variations. Would using a wind stress dataset that does capture these variations give better results in this respect?

- Even at higher latitudes in winter, there may be diurnal variations of wind that could force a current response (Clayson and Edson, 2019). Again, ERA5 may not capture this.

Clayson & Edson: <https://doi.org/10.1029/2019GL082826>

Ueyema and Deser: <https://doi.org/10.1175/JCLI1666.1>

Masich et al <https://doi.org/10.1029/2020JC016982>

Cherian et al <https://doi.org/10.1175/JPO-D-20-0229.1>

Reeves Eyre et al <https://doi.org/10.1029/2023GL104194>

Current datasets

The references to different current datasets throughout the text are inconsistent and confusing. I note the following datasets/notations, which are mostly used without further explanation or references to other publications or sources:

1. “Globcurrent CMEMS MOB-TAC” (line 10)
2. “(GlobCurrent)[now operational in CMEMS, or the OSCAR dataset]” (Lines 42-43). How many different datasets is this? Is OSCAR another name for the same dataset, or a different dataset?
3. “CMEMS” (line 66). The only one with a reference.
4. “CMEMS Multiobs total zonal current” (Figure 1)
5. “CMEMS Ekman estimate” (Figure 1 caption).
6. “CMEMS Ekman model” (Line 149)
7. “CMEMS MOB-TAC Ekman zonal current” (Figure 4)
8. “Globcurrent/CMEMS (including Ekman)” (Line 163)
9. “Globcurrent/CMEMS” (Lines 167 and several places thereafter)
10. “GEOS” and “CMEMS_total” (Figures 4 and 5)
11. “Altimetry” and “Ekman (MOB-TAC CMEMS)” (Figures 6 and 7)
12. “Geostrophy from CMEMS” and “Globcurrent/CMEMS (geostrophy+Ekman)” (Figure 6 caption)
13. “Operational Globcurrent MOB-TAC CMEMS” (Line 263)
14. “MOB-TAC CMEMS” (Line 267)

I probably could class this as a minor point, but it happens often enough to become a major source of confusion. Please pick a consistent notation and explain it early on. Give references for each distinct source.

Minor comments

Lines 57-58: Consider adding section 6 to the section descriptions.

Line 64: Reference to Argo positioning is incorrect. This should be “Argos”. Consider also adding a note that this is a distinct technology to ARGO buoys, as some readers may confuse this adjacent technology.

Line 66: Is the “CMEMS” here the same as the “CMEMS-MOB-TAC” mentioned in the abstract and Figure 3? If so, please explain that here. If not, please add a description of what the “CMEMS-MOB-TAC” is.

Figure 1: The time axis on the lower panel is quite unintuitive: if possible, replace with dates. Additionally, further symbols (like the red dot) translating between trajectory (in the upper right panel) and time (in the lower panel) would be helpful. E.g., a different symbol every 10-15 days.

Line 93: Give exact value of T. E.g., “T is set to be xxx hours, or approximately 1 week.”

Line 97: Change “studt” to “study”.

Lines 98-99: “ageostrophic motions not resolved by altimetry”. Aren’t the ageostrophic motions, by definition here, those parts of the total current not resolved by altimetry? Should this read “geostrophic motions not resolved by altimetry”?

Line 106: Please define “r”.

Sections 3.2 and 3.3: Please take care to ensure consistent bold or regular fonts for characters in the equations and in the text. If the different fonts are meant to be different, please explain the significance.

Line 148: What does “WOC” stand for?

Figure 3: Consider changing the labels of “Unsteady-Ekman zonal current” to WOC, for consistency with the text.

Figures 4 and 5: Consider adding vertical lines corresponding to intuitive frequencies: e.g., at 12-hourly, 24, 48, 120, and inertial for representative latitude. Also, consider y axis labels.

Line 170: Change “barotopic” to “barotropic”.

Line 185: Discuss physical significance of counterclockwise compared with clockwise.

Figure 8: Add some kind of depiction of inertial frequency for relevant latitude.

Line 251: Change “Figure 8” to “Figure 9”.

Line 254-255: It could be helpful to illustrate this end point concept on one or more of the figures.

Figure 9: It is slightly confusing to refer to the axes as real and imaginary in the caption (and line 251), but label them U and V on the panels' axis labels. Please make them consistent one way or the other.

Line 266: Unclear what "remains overall of 10%" means. Please clarify.