This study showed a close spatio-temporal covariability between biogeochemical module based on CoSINE model and kinetic energy based on ocean current from ADT in summer Vietnam upwelling system. The model results show that weakened circulation and eddy activity, with ~21% less nitrate inventory and ~16% weaker primary productivity when separation current is absent.
My impression on this manuscript is that two different physical and biological perspectives are well linked together to address productivity changes in response to physical forces. However, I found some misleading facts from the results that this paper discussed. Thus, I would like to recommend to accept this paper for the publication of OS after some revision.

Response: We appreciate the positive feedbacks from the referee. Please see point-by-point responses below.

Major Comments:

1. Is there any critical condition to explain that the elevated kinetic energy and intensified circulation can be explained by the separation of the upwelling current system (as described in Abstract).

Response: It is a good point to further quantify the flow separation. Additional discussion was added to Appendix B. We also revised this sentence to make it clearer: "the elevated kinetic energy and intensified circulation are linked to the separation of the upwelling current system." Qualitatively, both the analysis based on remote sensing data and model results suggest the separation flow is linked with stronger KE (~65% larger in HNA case then LNA case, Line 187). Moreover, a separation index is defined to quantitatively explain the relation between the flow separation and intensified circulation. The separation index (SI) can be written as:

$$SI = \sum \frac{u \cdot \cos\varphi + v \cdot \sin\varphi}{\sqrt{u^2 + v^2}}, \qquad \text{(S1)}$$

where u and v are the two surface velocity components, and φ is the angle between the topography gradient and the positive x axis. This SI is essentially the area-averaged cross-isobath velocity normalized by the magnitude of the velocity, which is used to quantify flow separation here.

Fig. S1 shows the distribution of SI in Aug 2010. Positive values indicate that the flow is separating and downslope, and that may be seen off Vietnam south of the coastline bend. Large SI (~1.0) can be observed near the separation point ~11.5°N. Taking spatial average over the box region in Fig. 2a or Fig. S1, there is a good positive correlation ($R=0.7175$, $p<0.01$) between log(KE) and SI (see Fig. S2). Moreover, SI may be seen to generally increase with KE to a value of 0.25~0.3 and then it levels off (i.e. the slope becomes less) – see the red and blue lines in Fig. S2. The log(KE) and SI thus appears to show a logistic-type behavior, in which SI asymptotically approaches some maximum value (in this case ~0.3).

This suggest that the strong flow separation and elevated KE are tightly linked. From Fig. S2, the value of KE ≈ 0.1 m^2s^{-2} appears to be a critical value.

Dynamically, the nonlinear advection term in the momentum equation can be written as the vector invariant form [see e.g., Gill (1982)]:

$$\vec{u}\cdot\nabla\vec{u}=(\nabla\times\vec{u})\times\vec{u}+\nabla(\frac{1}{2}\left|\vec{u}\right|^2)$$

This decomposition directly links the nonlinear advection term and the gradient of KE (which scales KE over a length scale L). Meanwhile, the nonlinear advection is an important mechanism in driving flow separation [see, for instance, Oey et al. (2014)]. Stronger advection suggests intense cross isobath flow. Therefore, a dynamic linkage between the flow separation and the intensified KE and circulation can also be established, further supporting this argument.

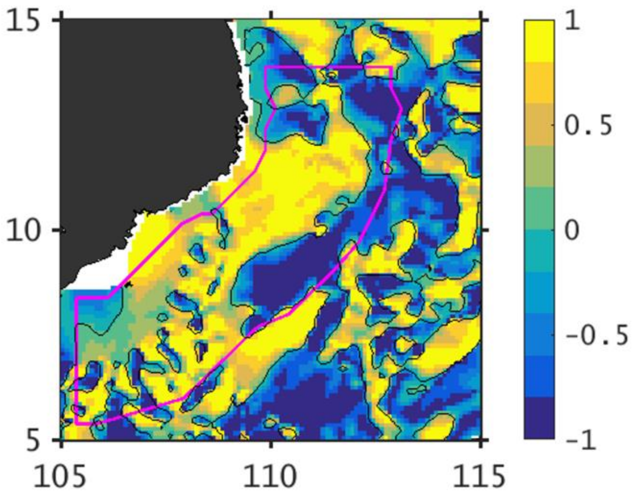


Figure S1 Example of modeled SI in Aug 2010.

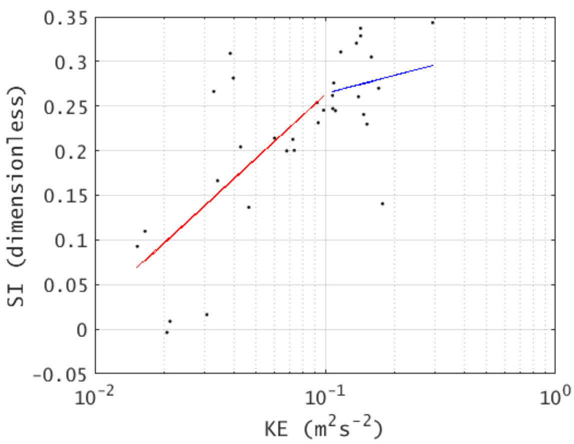


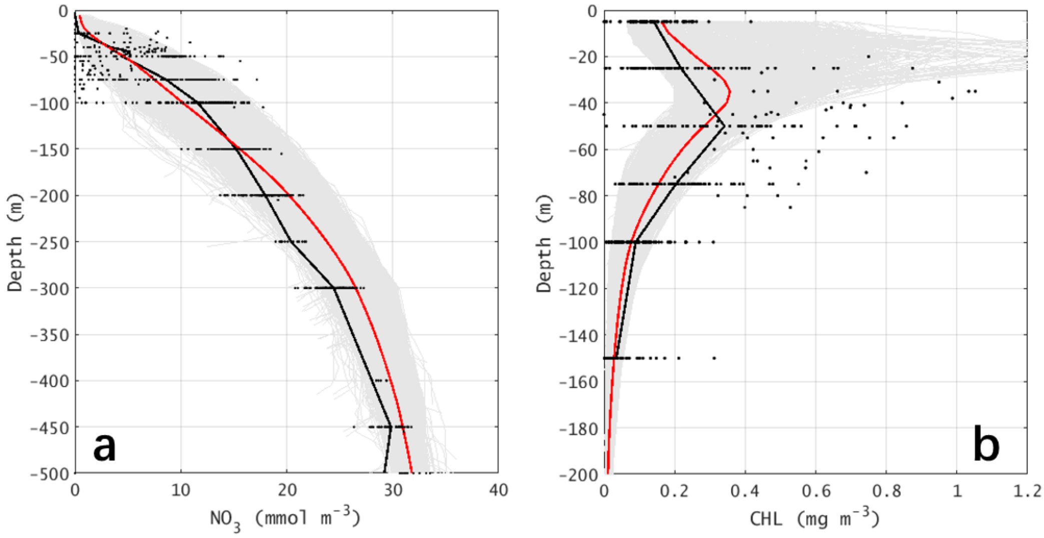
Figure S2 Summer-month (MJJAS) KE vs SI averaged over the box region in Fig. S2 (overall R=0.7175).

2. Authors discuss Figure 5 for model comparison with OISST and VGPM NPP. To me, model SST and NPP are not quite similar. Although authors admit its discrepancies, authors need to estimate this SST differences can cause how much uncertainties to obtain the result from covariability in physical-biological interaction.

Response: Thank you for this comment. We agree that the modeled and observed patterns did not match so well. However, while it is true that SST affects NPP through, for example, changes in the vertical stratification of the water column, both SST and NPP strongly depend on circulation (e.g. upwelling and/or downwelling), and in our case on the flow separation and KE also. In turn, the circulation is dominated by changes in the upper-layer depth (as diagnosed through the SSH) and the horizontal gradients of SSH, and is much less dependent on the gradients of SST. Thus, the co-variation between the SST and ecosystem is largely controlled by the circulation, as discussed in the manuscript. The dominant ecosystem response is the separation and non-separation contrast, which is captured well by the model (compare Fig. 4 and Fig. 8).
Discussion on this point was added to Line 198 through 204.

3. For Fig. 7 (Line 218), "Subsurface CHL maxima appears at ~35 m, which is somewhat shallower than that in the observation." Authors also need to discuss this depth differences leading to how much uncertainties to obtain current results.

Response: Discussion was added in Line 219:
"Except for model uncertainty, this discrepancy may be also related with the undersampling in observed profiles (no water samples between 25 m and 50 m depth). When CHL is considered as a proxy of the production, vertical-integrated CHL is more relevant. The vertical-averaged (5 m to 150 m) CHL in the model and observation are 0.1595 and 0.1668 mg m^{-3}, respectively, which has a marginal difference (< 5%)."
Mean observation profiles were also added to Fig. 7, as the black profiles below.



Minor Comments

Fig. 1, Magenta diamonds for observation stations are not clear. Change them with another better color (maybe black color)

Response: Sure. Black color looks good as now they are in.

Fig.2 shows CHL concentraton in Fig. 2a. I am wondering whether its magnitudes are right. It seems too low. Authors need to check.

Response: In Fig. 2a, the averaged CHL value in the summer VBUS is ~0.15 offshore and >0.45 nearshore. These values are consistent with the values from literature, for instance (Fig. S3), Loisel et al. (2017). Noting that in Fig. 2a the nearshore CHL can be as large as 5.0 mg m^{-3} exceeding the color scale, we replaced the color scale with a log2 scale (Fig. S4 and revised Fig. 2).

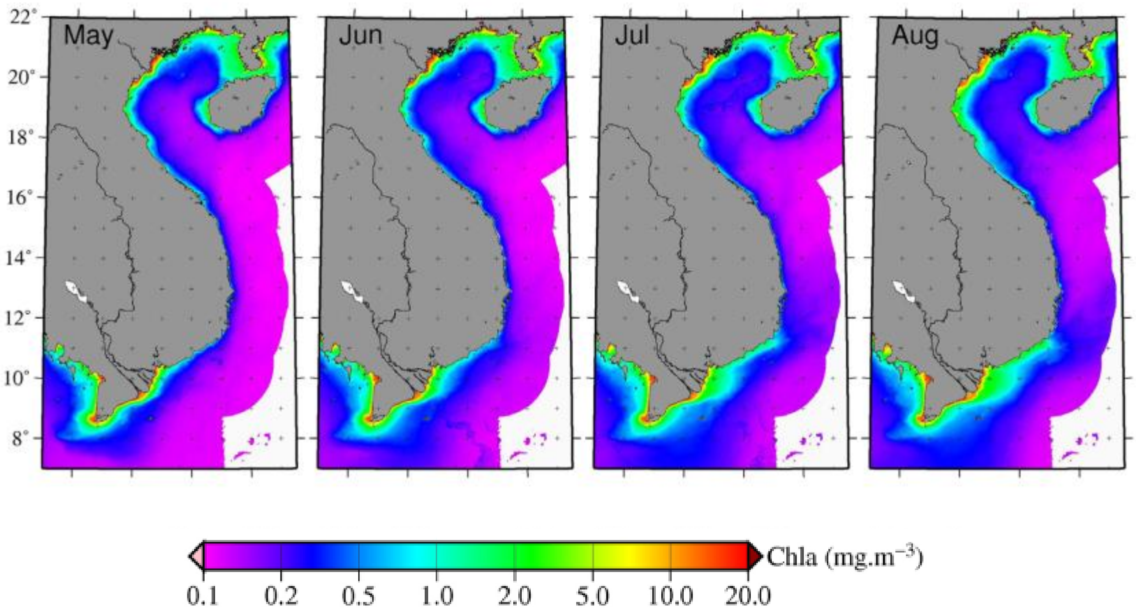


Figure S3 Climatological monthly CHL concentration from Loisel et al. (2017).

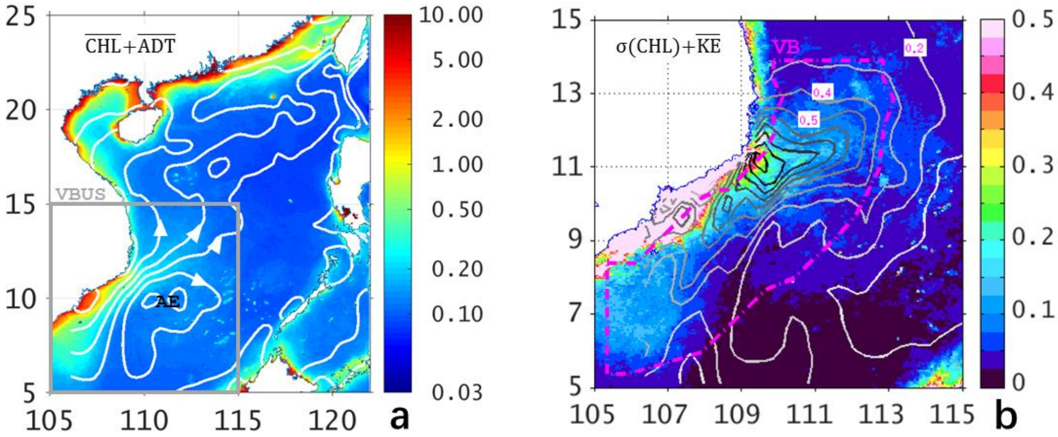


Figure S4 Revised Fig. 2.

References

Gill, A. E.: Atmosphere-ocean dynamics, Academic press, 1982.

Loisel, H., Vantrepotte, V., Ouillon, S., Ngoc, D. D., Herrmann, M., Tran, V., Mériaux, X., Dessailly, D., Jamet, C., Duhaut, T., Nguyen, H. H., and Van Nguyen, T.: Assessment and analysis of the chlorophyll-a concentration variability over the Vietnamese coastal waters from the MERIS ocean color sensor (2002–2012), Remote Sens. Environ., 190, 217-232, 2017.

Oey, L.-Y., Chang, Y.-L., Lin, Y.-C., Chang, M.-C., Varlamov, S., and Miyazawa, Y.: Cross flows in the Taiwan Strait in winter, J. Phys. Oceanogr., 44, 801-817, 2014.