Review of “Two different phytoplankton blooming mechanisms over the East China Sea during El-Niño decaying summers” by Lee et al.

Comment on egusphere-2024-3406 | Editor Comment:

In addition to the reviewer's comments, I also noticed that “chlorophyll a anomaly” in all relevant figures is currently labeled as “chlorophyll a”. Please change it to “chlorophyll a anomaly” or an appropriate symbol.

Response: We sincerely appreciate the editor’s valuable time and support in evaluating our work.

Following the editor’s suggestion, we have updated the labels of all the relevant figures to surface chlorophyll-a (SCHL) in the main text and supplementary figures to "SCHL anomaly" for consistency.

Comment on egusphere-2024-3406 | Anonymous Referee #3:

General comments

- The argument that satellite remote sensing Chla overestimate real Chl does not hold.

Algorithms for validating chl a from ocean color in coastal ocean have been well developed. For example, Figure 2 of Zhang et al (2017), cited in your last response, suggests the measured Chl and remote sensing Chl are very consistent at large range of Chl a concentrations in ECS. I have to wonder if the low Chl a anomaly simulated in your study is due to some problems with the biogeochemistry model that haven't been tuned for ECS regions, or other problems due to low resolution. Modelling work by Chen et al. (2021) shows good agreements between model and remote sensing Chl a (Fig. 2 of Chen et al., 2021), with chl anomaly around 1 mg m^{-3} by visual estimation. Wu et al. (2023. Fig. 7) show that the difference in Chl a due to changes in river discharge in different phases of ENSO is between -1 and 1 mg m^{-3}. I am not sure how your modeled river discharge of water and nutrients are consistent with ground truth. It is important to have a solid discuss why the Chl anomaly is so small.

Response: Actually, our model is a global-scale climate model with a relatively coarse resolution (1°×1°). In contrast, the model used in the reference suggested by the referee (Chen et al., 2021) is a high-resolution regional model simulation (ROMS) concentrated on the East Asian marginal seas, including the East China Sea (ECS). Therefore, the ROMS model—due to its higher spatial resolution—is better able to simulate observed surface chlorophyll-a (SCHL) concentrations, especially in narrow coastal regions like the Yangtze River estuary, compared to our coarser-resolution model.

Additionally, we compared modeled river discharge and observed to address the referee's concern. Since the model does not provide the river discharge variable from land, we indirectly evaluated the Yangtze River discharge by comparing the modeled liquid runoff over a spread grid domain (26.5°N–32.5°N / 121.5°E–125.5°E; approximately 660 km × 440 km) with observation-based discharge estimates. According to Guo et al (2018), the average annual discharge of the Yangtze River is reported as 10,870, 13,620, and 28,400 m^3/s at Cuntan, Yichang, and Datong stations, respectively. To represent discharge near the estuary, we used the value from the Datong station (28,400 m^3/s) for comparison. The corresponding area-averaged runoff from observations, when distributed uniformly across the estuary region, is approximately 9.78×10^{-5} $kg/m^2/s$. In contrast, the modeled mean runoff over the same region is 7.25×10^{-5} $kg/m^2/s$, which simulates rather well, about 74.1% of the observation-based estimate.

- Regarding the buoyancy-driven upwelling driven by river water plume is beyond my knowledge limit. I would appreciate any reviewers with 1 strong physics background to make the judge. However, As the buoyancy driven upwelling is argued to be the vector of runoff driven Chl a anomaly, but not quantified. It is only a hypothesis, and needs to be discussed, along with direct nutrient input from river water. Relevant literature that may collaborate the hypothesis should be cited.

Response: In response to comments from another referee, we have acknowledged the potential role of buoyancy-driven upwelling induced by river runoff in the Yangtze River Estuary (YRE). In the revised manuscript, we highlighted that, beyond the direct nutrient input from runoff, subsurface nutrient supply via buoyancy-driven upwelling could also play a significant role. The reference to Chen (2008), which explains this mechanism, was suggested by the referee. Additionally, we have incorporated several relevant studies—including Chen et al. (2003), Chen (2000), and Hill (1998)—that emphasize how strong river discharge can drive buoyancy-induced upwelling in coastal systems. These references have been cited to strengthen our discussion of this mechanism in the manuscript.

- Regarding Equation 4, I appreciate the VIF analysis, which is robust. This should be added to the presentation of results. However, the expression of the equation 4 does not agree with your text. Following your description, I guess $\delta Chl/\delta Runoff$ is the partial coefficient of Runoff on Chl change in the multiple regression between Chl a and three mechanisms. Then, is δRunoff/δNO3 the regression coefficient between ENSO index and Runoff? If that is correct, then my question is how you deal with the effects of runoff on PO4? That maybe ok for the effects of runoff on nutrient supply, as there is no PO4 in runoff. But how do you quantify the impact of upwelling (Ekman or buoyancy) and TS transport on PO4, as either NO3 or PO4 may be limiting phytoplankton growth in your model. This needs to be clearly and rigorously explained in the equations and texts.

Response: In the previous review, we calculated the variance inflation factor (VIF) for each mechanism to assess multicollinearity among the independent variables. As the referee suggested, we have added VIF values for each mechanism in the main text and included a brief description of typical VIF criteria that indicate whether they are statistically independent enough to be reliably quantified.

(L334-339): Before quantitatively assessing the relative contributions of each mechanism, we evaluated potential multicollinearity among the three mechanisms by calculating the Variance Inflation Factor (VIF). The VIF values for the three mechanisms—Runoff (1.265), TS-transport (1.08), and Ekman Upwelling (1.214)—ranged from 1.08 to 1.265, indicating minimal multicollinearity. VIF values below 3 are typically considered negligible multicollinearity, suggesting that the three mechanisms are statistically independent (Kock and Lynn, 2012; Kim, 2019).

Following the referee's suggestion, we conducted a quantitative assessment of the contributions of each mechanism to nutrient variabilities using Equation 4 in the main text. While the equation structure remained unchanged, we applied it to nitrate (NO_3) and phosphate (PO_4) instead of surface chlorophyll-a (SCHL). For the NO_3, the TS-transport mechanism was evaluated in the same method as for PO_4, with NO_3 concentrations substituted into equation 3 in the main text.

NO_3 results showed that the runoff mechanism emerged as the dominant contributor across the entire target region, with a contribution notably higher than those of the TS-transport and Ekman upwelling mechanisms (Table R1). Spatially, the strongest influence of the runoff mechanism was concentrated in the YRE, as expected, due to the model's explicit simulations of riverine NO_3 input. The TS-transport and Ekman upwelling mechanisms exhibited spatial patterns that were closely similar to those of SCHL (Fig. R1 and Fig. 9 in the main text).

Regarding PO_4, the runoff mechanism also showed the greatest influence overall—approximately twice that of the TS-transport mechanism (Table R1). However, the Ekman upwelling mechanism showed a negative effect on PO_4 concentrations across the entire target region but exhibited a localized positive influence in the YRE region, where phosphorus (P) limitation is known to prevail (Fig. R2 and Table R1). Notably, the impact of Ekman upwelling was most modest in the central-northern part of the target region. The runoff mechanism, showed its strongest effect on PO_4 concentrations slightly offshore from the YRE, indicating that even in the absence of direct riverine PO_4 input, buoyancy-driven upwelling may substantially contribute to nutrient enrichment. The spatial distribution of the TS-transport mechanism's effect on PO_4 was broadly consistent with those observed for both SCHL and NO_3.

Table R1. Relative contributions of three mechanisms to nutrients (NO_3 and PO_4).

	α	Runoff	TS-transport	Ekman Upwelling
Contribution to NO_3	0.32	0.177	0.076	0.033
Contribution to PO_4	0.366	0.113	0.059	-0.035
Contribution to PO_4 (YRE region)	0.218	0.122	0.088	0.027

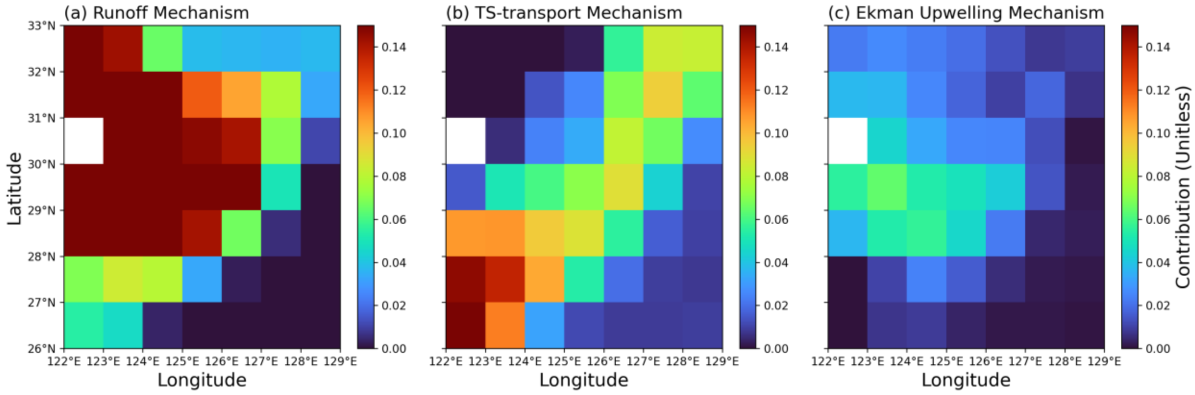

Figure R1. Relative contributions of three mechanisms to NO_3 anomaly in the target region during summers following the decaying phase of El Niño events (a) Runoff-driven mechanism (b) TS-transport-driven mechanism (c) Ekman upwelling-driven mechanism.

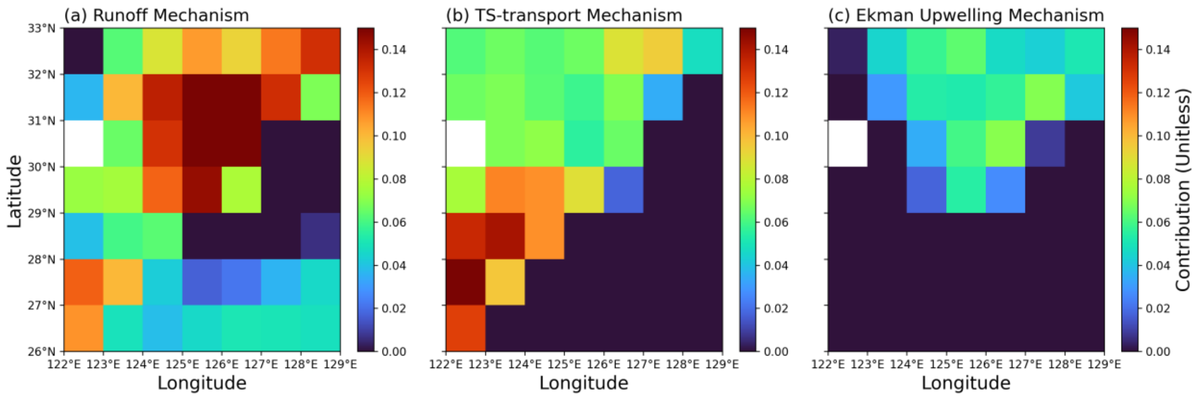

Figure R2. Relative contributions of three mechanisms to PO_4 anomaly in the target region during summers following the decaying phase of El Niño events (a) Runoff-driven mechanism (b) TS-transport-driven mechanism (c) Ekman upwelling-driven mechanism.

Reference

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