Review of the manuscript: Multiple mechanisms for chlorophyll-a concentration variations in coastal upwelling regions: A case study east of Hainan Island in the South China Sea

This works analyzes the seasonal cycle of the chlorophyll concentration and the factors affecting to such concentrations in an upwelling region close to the Hainan Island in the NW South China Sea.

This work is interesting and well written. It is easy to read and follow. The authors use a large number of variables, including satellite chlorophyll data, wind and curl of the wind, altimetry data, rainfall rates and *in situ* temperature, salinity and chlorophyll data from two oceanographic campaigns in July 2021 and October 2019. Beside this, euphotic layer depth and total suspended sediments are estimated from satellite data.

Considering the large amount of information provided in this work, I consider that it is a very exhaustive study and it merits publication. Nevertheless, there are several questions that need clarification previous to its final acceptance.

General comments.

I think that the organization of the manuscript could be improved. There is a section 1. Introduction, and then a section 2, Materials and methods, with several sub-sections for each data set. Then the section 3 is Chl-a concentration variations in the UEH, section 4 is Variations in environmental factors in the HEC, and section 5 is Factors related to variations in the Chl-a concentration, with a final section 6 for conclusions.

In my opinion, section 3 should be Results. The present sections 3, 4 and 5 should be sub-sections within the Results section.

In the present manuscript, sections 3, 4 and 5 (that should be sub-sections) include results and some discussion. The extension of the discussion in the present manuscript is too large for a section devoted to results, but is too short for a section devoted to discussion. I think that the results section should deal just with results, and include a new section for discussion and conclusions.

Detailed comments.

Introduction.

Lines 60-61. I need some clarification for this sentence: “In addition, the strong northeastward current along the shelf enhances upwelling (Su et al., 2013).” I do not understand how the current enhances upwelling. If there is a wind blowing from the SW (towards NE), then the circulation induced by the wind will be made of an along wind current in geostrophic adjustment, and an ageostrophic circulation which is responsible for the Ekman transport. The geostrophic current can advect the water and materials upwelled by the Ekman transport, but it is not responsible for the upwelling and therefore it does not enhance upwelling. Isn’t it? Anyway, I find the introduction well written and make it clear the objectives of the work.

Material and methods.

Lines 106-107. “…and are accompanied by high chlorophyll-a concentrations”. I would say “relative high concentrations”. These concentrations are high if compared with the open sea, so they are high, relative to the open sea. But the highest chlorophyll concentrations in figure 1b are observed in the river Pearl and to the SW of river Pearl, in the continental coast.

Lines 127-130:

“The wind data from May 2007 to December 2020 used in this study were a monthly product, which was estimated from daily global wind fields calculated from retrievals derived from advanced scatterometers (ASCAT). The wind data from January 2003 to April 2020 were calculated from the daily global wind fields obtained by quick scatterometers (QuikSCATs).”

I suppose that the data from QuickSCATs are for the period January 2003 to April 2007, instead of 2020. Otherwise the two dataset overlap.

Lines 159-160: “…The Chl-a data from the fluorescence sensor of the CTD were not calibrated, and the signals of interest were clear.” What is the meaning of this sentence? Clear?

Lines 168-171.

In equations (4) and (5), the Cartesian components of the wind u, v (eastwards, northewards) are transformed to u-along and u-across, using the coastline as x-axis. Now you use the equation: $Mx=-\tau y/f\rho$ for the Ekman transport normal to the coast. I think that you should use cross-transport and along-coast wind stress, to be consistent with the previous definition.

Lines 289-290. “These variations in the euphotic depth likely affect the vertical distribution of phytoplankton in the water.” Obviously light availability is one of the main factors controlling phytoplankton growth, but the inverse is also true. The phytoplankton abundance affects the light penetration as phytoplankton absorbs light.

Figure 5. Figures f1 to f4 show the chlorophyll concentrations for the four seasons of the year. But the four figures look exactly the same. I guess it could be because of the use of logarithmic scale? Please re-make this figure to enhance the differences between different seasons, or explain why all the seasons have the same chlorophyll distribution.

Line 302. “4.3 EOF analysis of Chl-a concentration”.

The authors present results from EOF analysis in this section, but it was not explained in the Materials and methods. Obviously it is a very well known statistical technique, but a brief description should be included. For instance, if you have “n” satellite chlorophyll images with “m” pixels each image, one possibility is to consider the “m” time series of chlorophyll corresponding to the “m” pixels. Each time series has “n” data. In order to obtain the EOFs, you calculate the m x m covariance matrix. Is this the procedure you followed? Previous to the calculation of the covariance matrix you can subtract a mean value, or the seasonal cycle? How did you do it? I guess you did not subtract the seasonal cycle because your first EOF accounts for it, but these things should be explained.

Line 359 and followings. “a salinity front occurs approximately 60 km from the coastline at a depth of ~100 m. This salinity front indicates that fresh water is injected into the sea surface”. I do not see this clearly. I see an area of fresh water ~32.8 from the coast to 60 km at the sea surface. Therefore this front would be located at the surface, not at 100 m. At 60 km and at 50 m depth, isohalines are almost vertical and this constitutes a salinity front. But this front is different from the front at the sea surface. The latter is caused by the upward displacements of isohalines, not but the injection of fresh water. In my opinion, the origin of this frontal area at 50 m depth seems to have a dynamical origin. At 100 km, the isohalines are in a vertical position again. Hence, it looks as if there is a depression or sinking of isohalines and isopycnals between 50 and 100 km, suggesting the presence of an anticyclonic circulation cell.

Role of coastal current.

I need some explanations in this section because I do not understand it very well. In lines 415-417, the authors say: “The climatological sea surface sloped considerably toward the ocean in October, November, and December. The sea surface on the shelf was lower than that in the ocean”. But in figure 10a, I see just the opposite. The curves for October, November and December are higher at the shelf than in the ocean. Notice that the orientation of this figure is different from figure 8. In figure 8 land is to the left and in figure 10 land is to the right. According to my interpretation and equation (6):

$u = -g/f \, \partial\eta/\partial y$ u is positive in October, as you state in line 422 (0.17 m/s). But if the sea surface was lower at the shelf, then the $\partial\eta/\partial y$ would be positive, as y-axis is positive seaward (Materials and methods), and the u component of geostrophic velocity would be negative. Furthermore, the distribution of isopycnals in figure 8g suggests that the sea surface is higher at the shelf. Isopycnals of 24 kgm-3 and higher sink towards the coast. Therefore lighter water sinks at the coast and sea level must be higher to compensate for it, if a no-motion reference level exists below (basic assumption of geostrophy).

Maybe the problem comes from the following sentence: “The geostrophic current shows that the current was positive (northeastward) between April and August”. According to lines 134-135: “where the cross-shelf wind, *v*cross, is seaward positive; the along-shelf

wind, *u*along, is southward parallel to the coastline". I understand that southward is positive. In April to August, the sea level increases seawards according to figure 10a. Then $\partial\eta/\partial y$ is positive and according to (6), u is negative, that means that the current is directed northwards, in agreement with the sign criterion of materials and methods and coinciding with the summer monsson.

Maybe I have not understood this properly, but I need some clarification.