Dear Editor and Reviewers

We are very pleased to have your comments concerning our manuscript entitled "Multiple mechanisms for chlorophyll-a concentration variations in coastal upwelling regions: A case study east of Hainan Island in the South China Sea" (egusphere-2022-969). Thank the editor and reviewers for taking time out of your busy schedule to review our paper and provide constructive comments on it.

We have read and dealt with all the comments carefully. The revised manuscript with all comments highlighted with blue fronts has been uploaded, and point-to-point responses to the reviewer's comments are present following. Furthermore, reference list and color schemes used in figures (Figs 2d, 4b and 5c) have been compiled.

Response to Comments of Reviewer 1 （Blue font in the manuscript）

[Comment 1] In section 3.2 the explanation about the insignificance of trends, from line 260 to 262, should appear after line 280 or at the end of the section, because not only the trends of UI and WSC but also the trends of upwelling area and UEH SST are not statistically significant. Besides, please change "HEU" in Fig. 4b to "UEH".

Response: Thank you for your careful reading.

(1) We have removed the sentence to the end of this section.

Lines 276-278

"Because the period of data is only 18 years, it is a little too short to demonstrate the significance of the trend of wind and SST data. Therefore, *p* value and *r* are not so statistically significant owing to the limitation of data."

(2) We have corrected the word "HEU" in Fig. 4b.

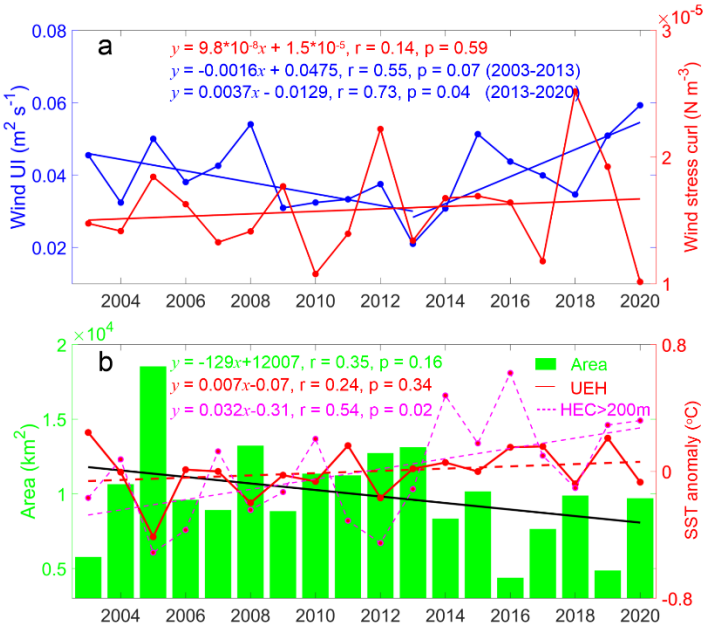

Figure 4. Time series of Upwelling index (UI) and upwelling characteristics. (a) Time series of mean sea surface wind UI and wind stress curl in HEC region. Blue dotted curve denotes the mean UI during June-August; the red dotted curve is mean wind stress curl during June-August; and blue and red curves are the trends of the UI and wind stress curl, respectively. (b) Time series of upwelling

area and SST. Green bar denotes the area of UEH region. Red and magenta dotted curve denote mean SST of UEH region and slope region (depth>200 m) in HEC, respectively. Black, red and magenta curves are the trends of the upwelling area, mean SST in UEH and slope area, respectively.

[Comment 2] Line 312-313: -0.3 is the correlation coefficient between wind UI and Chl-a from 2003-2012 or 2003-2020? If for 2003-2012, how about the relationship between wind UI and Chl-a from 2013-2020?

Response: Thank you for your careful reading.

(1) A negative value, -0.3, is the correlation coefficient for the data from 2003 to 2012.

(2) The correlation coefficient during 2013-2020 is about 0.2. Firstly, as we can see in Fig.4, the wind stress curl is more important than wind stress for upwelling in 2018. Secondly, a typical strong ENSO event occurred in 2015-2016. Therefore, the relationship between wind UI and Chl-a from 2013 to 2020 looks like irrelevant. We have added a sentence to improve the description.

Lines 307-308.

"The main reason for the negative relationship is the low background SST during 2003-2012."

Lines 314-318.

"The relationship between wind UI and Chl-a concentration looks like irrelevant during 2013-2020. The main reasons are the strong ENSO event in 2015-2016 and the strong wind stress curl in 2018. High wind UI and wind stress curl occurred in 2015-2016 combined with high Chl-a concentration. In 2018, a strong wind stress curl with weak wind UI induced a strong upwelling process (low Chl-a concentration) as shown in Figure 4."

[Comment 3] Line 494-500: "During El Niño events, the weakened southwesterly monsoon suppresses ocean upwelling (Jing et al., 2011; Kuo et al., 2008). The reverse occurs during La Niña events. Jing et al. (2011) found that the significantly strengthened wind stress of the 1998 summer induced strong upwelling, and the Chl-a concentration was much higher than in any of the other years. Yu et al. (2020) showed that the interannual variability indicates low levels of Chl-a southeast of Vietnam during El Nino years because of the weakened southwest monsoon. These previous studies conclude that the weakening sea surface wind appears in El Nino years". Note that in Jing et al. (2011)' work, they demonstrated that the wind stress strengthened in the continental shelf of the northern South China Sea (SCS), particularly in the eastern Hainan Island - the same area of this study, in summer 1998 associated with the 1997-1998 El Nino, not La Nina. They also indicated that due to the anticyclonic atmospheric circulation anomaly over the SCS and northwest Pacific, the local southwesterly winds in the northwestern SCS are dramatically enhanced, whereas the southwesterly winds are weakened in the central and western SCS (Fig. 8 in their work). Jing et al., (2011) is contrary to the conclusion drawn in the last sentence as well as the author's response (1) to the fifth major comment.

Response: We gratefully appreciate for your valuable suggestion. We have checked the references carefully, and found the El Nino would enhance the wind stress in the eastern Hainan area. Moreover, there is time lag between El Nino and wind stress, about several months. In weak El Nino event, e.g., 2007 and 2010, the duration of El Nino is a little short, and it seems that the strong wind occurs in the consecutive La Nina event. In the typical El Nino event, i.e., 2015, it began in the winter of 2014, and the strong wind occurred in the summer of 2015. The strong wind induced a strong upwelling. Therefore, the Chl-a concentration was low in summer of 2015. We have corrected the

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Lines 491-494

"During El Niño events, the positive southwesterly wind anomalies would enhance the coastal upwelling in the SCS (Jing et al., 2011; Kuo et al., 2008). The positive southwesterly wind anomalies lag El Niño event several months (Hong and Zhang, 2021; Huynh et al., 2020). The reverse occurs during La Niña events."

Lines 496-503

"In 2005, the wind stress and upwelling area were much larger than that in 2004. And the Chl-a concentration decreased to 0.6 mg m−3 in June 2005. During 2015-2016, the wind stress and curl were both strong and the upwelling area was larger than that in 2014. There was anomalously high Chl-a concentration occurred in 2016. Jing et al. (2011) have reported analogously high Chl-a concentration anomaly in 1998. We should notice that a maximum SST occurred in 2016 with a maximum of Chl-a concentration. While, there were minimum value of background SST (Figure 4b) occurred in summer of the year 2008, 2011, 2012, 2017 and 2018 combined with minimum of Chl-a concentration (arrows in Figure 12)."

[Comment 4] Regarding the author's response (2) to the fifth major comment, note that Fang et al. (2006) and Huynh et al. (2020) also showed that the spatial variability of the monsoon winds under the El Nino (La Nina) effect is not in-phase in subregions of the SCS. In Hong and Zhang (2021), station C is located off the northeastern Leizhou Peninsula; Fig. 2b in their work shows that the trends of the annual mean wind speed between station C and the eastern Hainan are out-of-phase from 1979 to 2019, decreasing trends at station C, whereas increasing trends in eastern Hainan. A strong increasing trend of positive wind stress curl was detected in eastern Hainan during 1979-2019 (Fig. 10). Additionally, Hong and Zhang (2021) also indicated that the surface wind speed in eastern Hainan has a positive correlation with ENSO (Figs. 8-9).

Response: Thanks for your useful comment.

Yes, we agree with spatial variability of the monsoon winds under the El Nino (La Nina) effect. Figs. 2b and 10 in Hong and Zhang (2021) showed an increasing trend of wind speed and wind stress in the eastern Hainan area, which is the same with the Fig. 4a in this study.

Fig. 8 in Hong and Zhang (2021) showed a positive wind speed anomaly for Mode 1 and 3, while a negative anomaly in the eastern Hainan area in summer of 1997. In the summer of 1998, the positive wind speed anomaly occurred in all the three Modes in the eastern Hainan area. The figure showed a negative wind speed anomaly in the summer of 1999 and 2000. In 2015, the positive wind speed anomaly occurred once again. Moreover, from Fig. 9, one can see that the wind lags Nino index several months. Therefore, the surface wind speed in eastern Hainan has a positive correlation with El Nino.

We have corrected the manuscript about the relationship between ENSO and wind UI. The higher (lower) wind speed occurs during El Nino (La Nina) event in the eastern Hainan Island. And, we have added the reference into the manuscript.

Lines 491-494

"During El Niño events, the positive southwesterly wind anomalies would enhance the coastal upwelling in the SCS (Jing et al., 2011; Kuo et al., 2008). The positive southwesterly wind anomalies lag El Niño event several months (Hong and Zhang, 2021; Huynh et al., 2020). The reverse occurs during La Niña events."