DOI: 10.15625/vap.2019.000138

OCEAN-ATMOSPHERE INTERACTION OVER UPWELING REGION OFF CENTRAL VIETNAM: OBSERVATION STUDY

Le Van Thien

Hanoi University of Natural Resources and Environment, Hanoi, Vietnam
Email: thienmet@gmail.com

ABSTRACT

Observations from satellites have shown a statistical relationship between the surface wind stress and underlying sea surface temperature (SST) on space and time scales, in many regions. Using satellite- derived data, the variability in wind and SST is examined for a particularly strong upwelling summer season off central Vietnam coast in 2002. The sea surface temperatures (SSTs) over these regions can fall to about 26°C on average during July 2002 when a strong localized upwelling event occurred near 10.5°N–12°N. High variability in winds and SSTs were found over the upwelling region. Prevailing southwesterly strong winds apparently drove upwelling in coastal areas due to Ekman pumping effects off central Vietnam. The strongest alongshore winds occurred in July are due to pressure contrasts between the land and sea distribution and the changing thermodynamic over the area of study.

Keywords: Upwelling, ocean-atmosphere interactions, central Vietnam.

1. INTRODUCTION

Upwellings are one of the most important research topics because they pump subsurface nutrient-rich water to the sea surface, which in turn results in significant enhancement of phytoplankton blooms. Seasonal upwelling in the Vietnam East Sea (VES) has been recognized for more than half a century. Several studies have focused on the impacts of and/or mechanisms underlying this seasonal phenomenon [1,2,3]

The fisheries sector is one of the important contributors to the socioeconomic development Fishing takes place mainly over the nutrient rich upwelling regions. The synoptic winds, which drive the upwelling over the coast, are predominantly from the southwest during June–August.

In this paper, we report results from satellite- derived data that describe the variability of the wind during a strong summer upwelling event in the coastal area off central Vietnam.

2. STUDY AREA AND SATELLITE DATA, AND METHODS

2.1. Study area

The study region is the area off central Vietnam (area in Fig. 1, 104^0E – 113^0E, 8^0N – 15^0N). This region experiences reversal monsoon with weak northeast monsoon in the winter and strong southwest monsoon in the summer.

2.2. Satellite-derived surface vector winds

Sea surface vector winds have been measured from the microwave scatterometers [4]. We used 0.5-degree monthly mean wind fields obtained from the QuickBird satellite which was launched in June 1999. QuikScat is a radar device that transmits radar pulses down to the Earth's surface and then measures the power that is scattered back to the instrument. Wind speed and direction over the ocean surface are obtained from measurements of the QuikScat backscattered power [4].

2.3. Satellite-derived sea surface temperature

National Oceanic and Atmospheric Administration (NOAA) satellites provide SST observations form Advanced Very High Resolution Radiometer (AVHRR) instruments. AVHRR images with 1.1 km spatial resolution at nadir were obtained from satellite [5]. The cloud free images were processed to obtain the multi-channel SST data [6; 7]. Then monthly SST data were obtained by arithmetically averaging all available scenes in each month on a pixel by pixel basis.

3. RESULTS

Figure 1 showed that cold SST tongue off central Vietnam arose in June (Figure 1a) and reached maximum magnitude in July (Figure 1b) and decreased in August (Figure 1c), extending eastward over the central ES. SST cooling was centered around 109°E–113°E, 10.5°N–12°N (referred to as the off central Vietnam upwelling event domain), spreading slightly toward the northeast over the central ES.

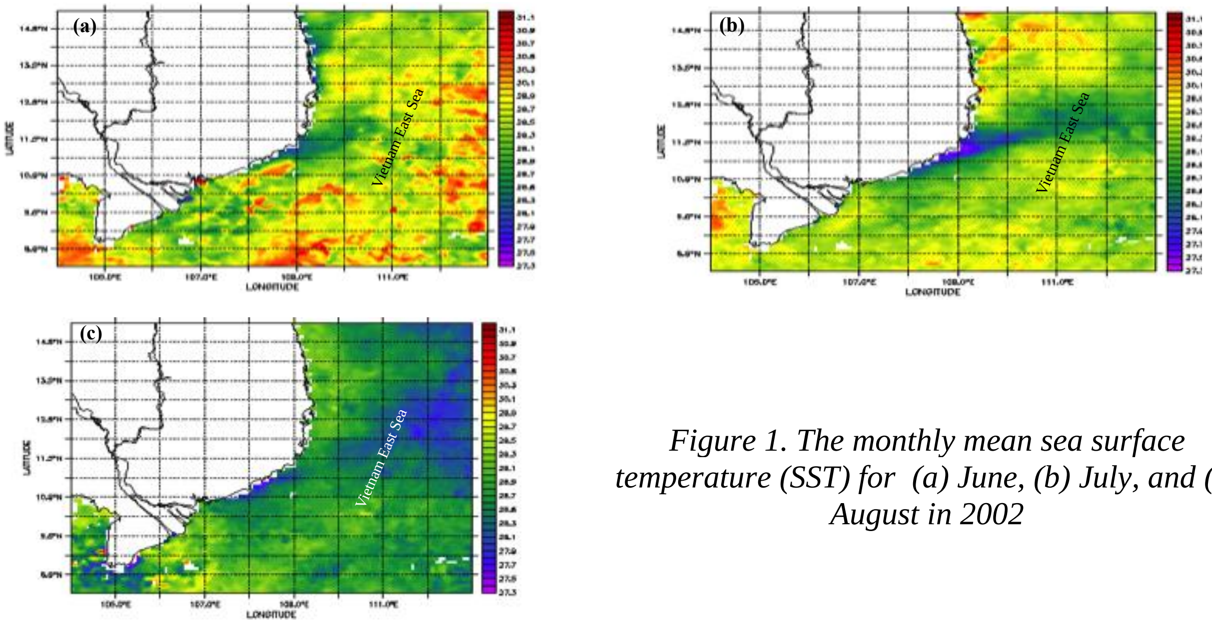


Figure 1. The monthly mean sea surface temperature (SST) for (a) June, (b) July, and (c) August in 2002

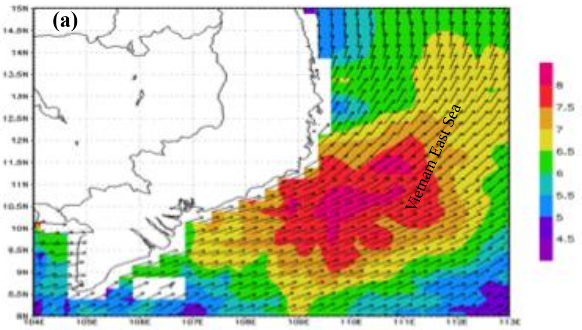
Figure 2 presents horizontal snapshots of the near- surface monthly wind field over the domain during June-August of the 2002 and indicates that the strongest alongshore winds occurred in July (Figure 2b). These winds then weakened considerably during August (Figure 2c). The strong alongshore winds are reflected in the changing pressure contrasts between the land and sea distributions that induce large pressure gradients over the area of study.

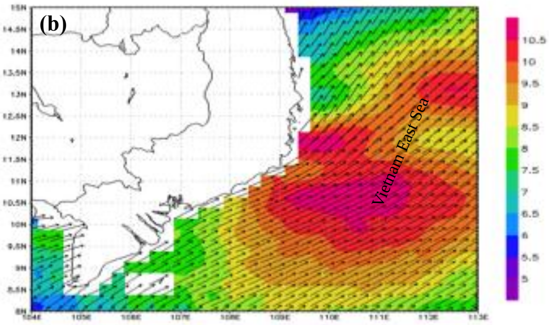
During July 2002, sea level pressure in the north was anomalously lower compared to average, whereas those over the south was anomalously higher (Figure 3), thereby implying a stronger pressure contrast or large pressure gradients in July 2002. On the basis of these observations, these results can imply that the strong winds during July 2002 strengthened the ocean current and led to the upwelling region off central Vietnam because of Ekman pumping.

4. CONCLUSION AND DISCUSSION

Satellite- derived winds and SST facilitate the analysis of covariability in these fields. This study presents an analysis of wind and SST characteristics over the central Vietnam upwelling region.

The dynamics associated with the observed intense upwelling are not yet well understood. This study has shown that spatial variations in wind are found along the central Vietnam coast. The role of ocean bottom topography and coastal curvature may be factors that contribute to explain the spatial variations of this nature and the associated coastal upwelling. The results reported on here suggest that ocean-atmosphere coupling could also greatly control the upwelling. The stronger winds associated with the changing air pressure contrasts between the north and south of upwelling region may lead to enhanced offshore Ekman transport there.





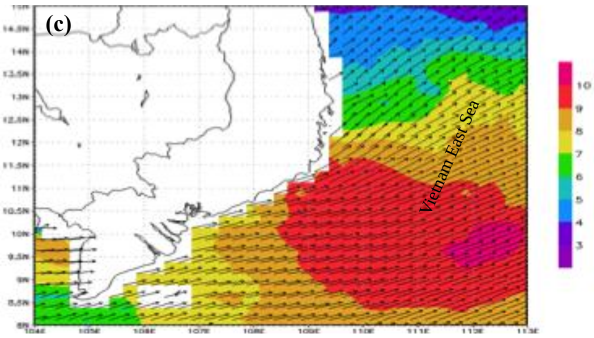


Figure 2. The monthly surface winds (vector) in (a) June, (b) July, and (c) August in 2002

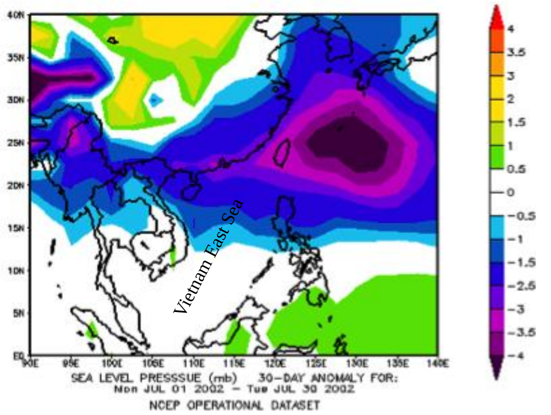


Figure 3. Anomaly sea level pressure in July 2002.

REFERENCES

[1]. Zheng, Z.-W. et al. (2016). Impacts of coastal upwelling off east Vietnam on the regional winds system: An air-sea-land interaction, Dynamics of Atmospheres and Oceans, 76, 105–115.

[2]. Hu, J., Gan, J., Sun, Z., Zhu, J. & Dai, M. (2011). Observed three- dimensional structure of a cold eddy in the southwestern East Sea. *J. Geophys. Res.: Oceans*, 116.

[3]. Kuo, N.-J., Zheng, Q. & Ho, C.-R. (2000). Satellite observation of upwelling along the western coast of the East Sea. *Remote sensing of environment 74*, 463–470.

[4]. Wentz F.J., Smith D.K., Mears C.A., and Gentemann C.L, 2001. Advanced algorithms for QuikScat and SeaWinds/AMSR, paper presented at IGARSS '01, NASA, Washington, D.C.

[5]. Hsu, C. -H., Lee, K. -T., Lee, M. -A., Liao, C. -H., & Lu, H. -J. (2000). Effects of seasonal environment changes on the mackerel purse seine fishery in the waters off northeast Taiwan monitored by satellite remote sensing. Proceedings of the joint Taiwan–Australia aquaculture and fisheries resource and management forum (pp. 257–261). Keelung, Taiwan: Taiwan Fish. Res. Inst.

[6]. Kubota, M. (1994). A new cloud detection algorithm for nighttime AVHRR/HRPT data. *Journal of Oceanography*, 50, 31–41.

[7]. Simpson, J. J., & Humphrey, C. (1990). An automated cloud screening algorithm for daytime Advanced Very High Resolution Radiometer imagery. *Journal of Geophysical Research, 95(C8)*, 13459–13481.