OBSERVED THE INDIAN OCEAN DIPOLE 2011 FROM SATELLITE AND *IN-SITU* IN WEST JAVA SEAWATERS

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ABSTRACT

The Indian Ocean Dipole (IOD) phenomenon is the important manifestation of the tropical air-sea interaction in Indian Ocean. In this study, we analysis both data from the Moderate Resolution Imaging Spectral (MODIS) and in-situ observation in west Java seawaters during survey on September 2011. In-situ measurement was conductedusing the researh vessel (Mandidihang-3). Negative anomaly of sea surface temperature (SST) were found in the west Java as an impact of strong upwelling and also observation from vertical profile of temperature. The lower SST in south Java sea waters develop in July to November 2011 near the coastal of west Java seawaters.

Keywords:*Indian Ocean Dipole, upwelling, SST, west Java waters*

1. INTRODUCTION

The Indian Ocean Dipole (IOD) is a coupled ocean and atmosphere phenomenon in the equatorial Indian Ocean and characterized by anomalous cooling of SST in the south eastern equatorial Indian Ocean of Indonesia.The IOD phenomenon was first published by researchers in 1999 (Saji *et al.*, 1999; Webster *et al.*, 1999).

The IOD events have significant impact on people's lives. When the Indian Ocean Dipole Mode Index (IODMI) is positive, it leads to droughts over the Indonesian region and heavy rains and floods over the East Africa (Ashok *et al.*, 2001). At the same time the upwelling of high chl-a concentration waters along the coast of Sumatra and south Java(Iskandar *et al.*, 2009; Susanto *et al.*, 2006). Coral mortality occurred along a 400-km stretch of Indonesian coastline off Mentawai Islands (Abram *et al*., 2003). Therefore, the IOD dynamics research and its influence on human life needs to be done continuously.

Generally, IOD studies has been done by analyzing remote sensing data and modeling. However the direct measurements by using reseach vessels are rare.Therefore, we have done research in the eastern Indian Ocean off Java by using the research vessel (Madidihang-3) during IOD event in 2011.

2. METHODS

2.1 Data

This study was conducted by operating a research vessel and satellite image analysis.Field survey conducted by using research vessel "KM Madidihang 03" (Figure 1) on September 15-18, 2011. Vessel with length 50 meter, weight 723 GT equipped with research equipment such as CTD SBE 911plus 6600, and Scientific Echosounder EA 600. Track of research vessel and the vertical profile measurement

stations (ST-1, ST-2, and ST-3) in the West of Java seawaters is shown in Figure 2.

Figure 1. Reseach Vessel "Madidihang-3"

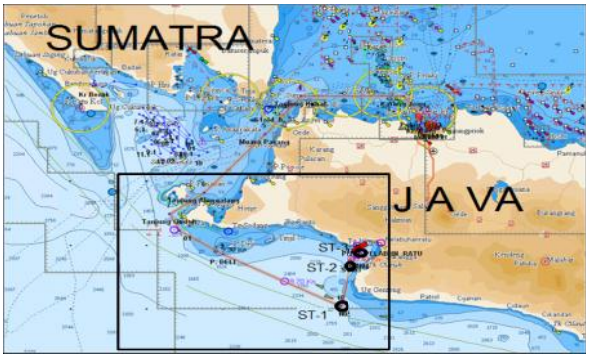

Figure 2. Track and the CTD-Stations

The SSTtime series data (2004-2013) was obtained fromGiovanni-Interactive Visualization and Analysis website (http://gdata1.sci.gsfc.nasa.gov/) (Acker and Leptoukh, 2007).

2.2 Data Analysis

The Continous Wavelet Transform (CWT) analysis was used to determine the power spectrum density of SST. Temperature data from CTD plotted vertically to determine the vertical profile of temperature at each station.

3. RESULTS AND DISCUSSIONS

The time series of SST in west Java seawaters is shownFigure 3. The average of SST during Southeast Monsoon is 26.5 ^{o}C and during the Northeast Monsoon is 29.0^{o}C.

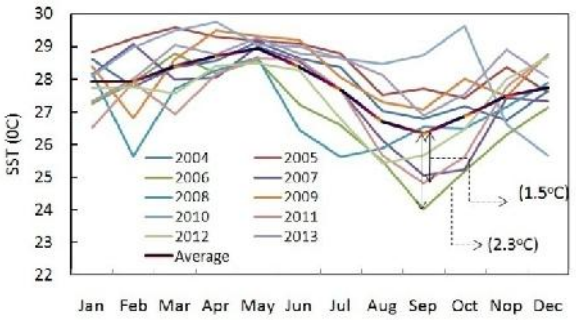

Figure 3. Monthly mean of SST in West Java

The CWT analysis of SST (Figure 4) showed two dominant signals with period of 12 and 64 months which represent the annual and the interannual variability of SST in west Java Seawaters.The seasonal variations are influenced by Moonson meanwhile the interannual influenced by IOD (Saji *et al.*, 1999).

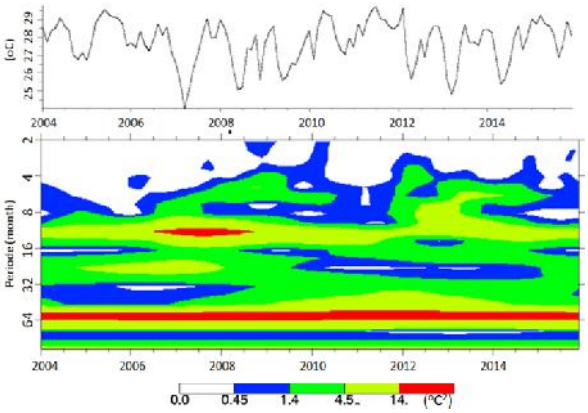

Figure 4. Variations of SST in West Java sea waters and wavelet analysis spectrum

The spasial distribution of SST in west Java seawaters during IOD positive phase (August to Novemberin 2006 and 2011) are shown in Figure 5.Normally, the range of SSTin west Java seawaters is 28-29^{o}C but during IOD positve phase the SST decreased sharply around 25-26^{o} C.The decrease of SST due to strong upwelling along the south Java and west Sumatra.

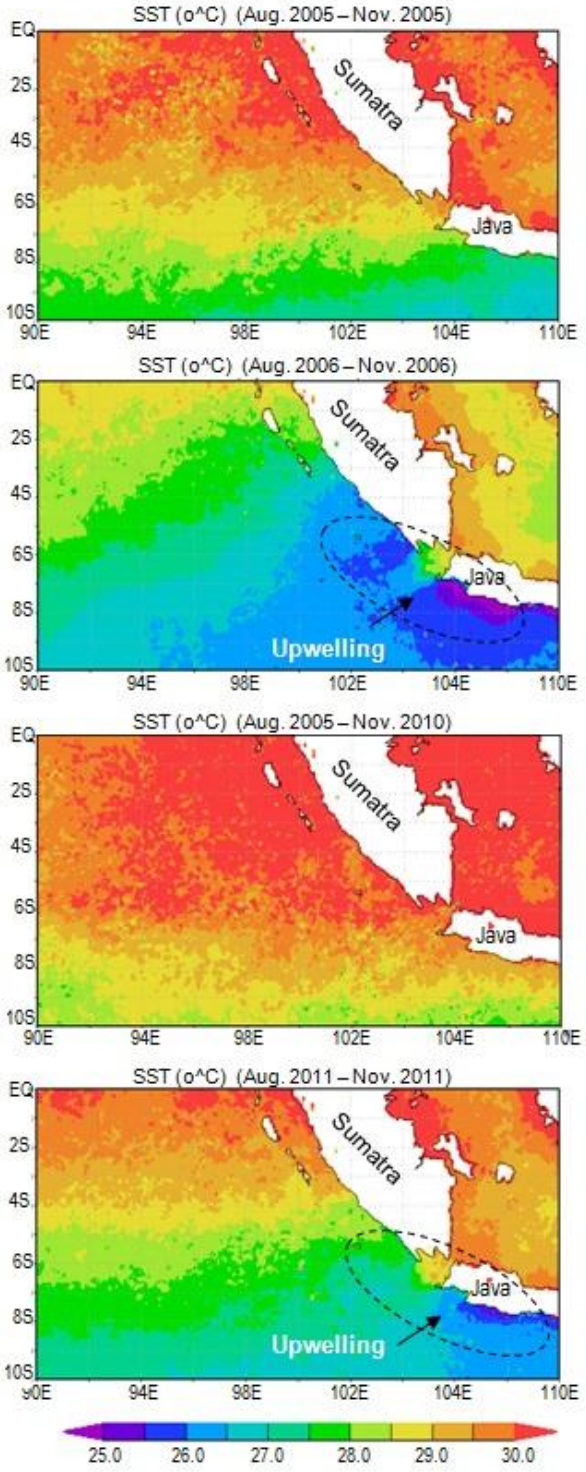

Figure 5. Spastial distribution of SST in west Java during normal condition and IOD

Hovmuller plot of SST from 2006 to 2012shown in Figure 6. Clearly, the negative SST anomalies occur between July to September during IODpositive event.

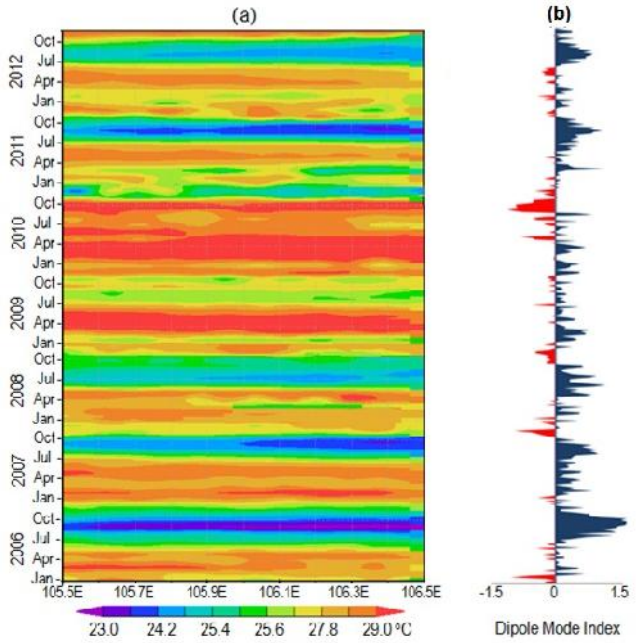

Figure 6. Hovmuller plot of SST from 2006 to 2012

The SSTnegative anomalies during the phase of IOD positive in accordance with the vertical profiles of temperature in west Java seawaters (Figure 6).In these pictures, clearly demonstrated the differences of water masses profiles in the IOD event compared with the nomal conditions. Mixed layer deph during IOD event becomes shallower. Shallowing of the mixed layer showsthe strong upwelling process during IOD.

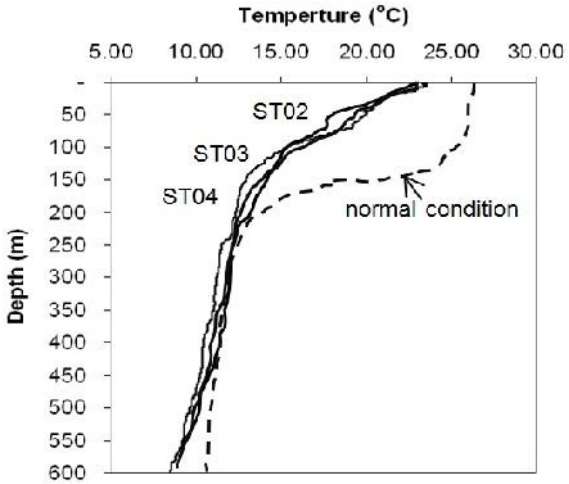

Figure 6. Vertical pofile of temperature in west Java seawaters

4. CONCLUSION

Spatial distribution of SST from satellite images show a negative anomaly SPL in west Java seawaters during IOD positive. Vertical temperature profiles show that the mixed layer depth shallower during positive IOD. The occurrence of strong upwelling during positive IOD clearly both from satellite imagery as well as of the vertical structure of water masses in the south of Java.

Acknowledgments

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