SURFACE CURRENTS IN INDONESIAN SEA BASED ON OCEAN SURFACE CURRENTS NEAR – REALTIME (OSCAR) DATA

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ABSTRACT

Indonesia located between two ocean (Pacific Ocean and Indian Ocean), and two continents (Asia and Autralia). This condition affect the ocean currents movement and velocity in this area. The purposes of this study are to analyze the movement and velocity of surface currents in Indonesian sea, based on OSCAR (ocean surface currents near – realtime) data. The result of this study shows that the currents velocity can reach 2,6 m/s. Around the equator area shows the highest velocity. The movement of surface currents in this area also fluenced by Southeast monsoon and Northwest monsoon.

Keywords: Surface Current, Ocean Surface Currents Near – Realtime, OSCAR, and Indonesian Sea.

INTRODUCTION

Ocean currents are movements of seawater in response to prevailing wind pattern and density variation in the oceans, or the result from the differences in the salinity and temperature of seawater. This currents bring in warmer or colder water, which modifies ecological conditions and influences the distribution such like festures as coral reef. the presence of this currents can affect beach forms and shore dynamics (Bird, 2007). In Indonesian Sea, the circulation systems of currents influenced by wind vector, moonson, and its location. During southeast monsoon, the movement of the wind from australia and asia continent that can influeced currents flow. While, when east monsoon occured is the contrary of it (Sulaiman, et al 2006).

The one of method to determine the surface current is using satellite data. This method not measure the ocean directly, but estimating current from wind vector and altimetry satellite (Dohan, 2010). The advantages gained in using this method is the range of wide observation area. Focus of this study is to determine surface currents based on OSCAR data for ten years data period. The aim of this study is to analyze surface currents in any monsoons in Indonesia.

Fig 1. Geographical location of Indonesia

OSCAR product has been validated by Johnson et. al., (2005). Johnson et. al conclude that the present OSCAR product provides accurate data of zonal and meridional time-mean circulation. Especially in the near-equatorial region, it's reasonably accurate estimates of zonal current variability at periods as short as 40 days and at meridional wavelengths as short as 8°. Validation proses was calculated with RMS errors method and compare with in situ data from Moored Current Meters (MCM), shipboard Acoustic Doppler Current Profiler (ADCP) and Global Lagrangian Drifting Buoy.

DATA AND METHOD

The Data was Obtained from the OSCAR data series (www.oscar.noaa.gov) during ten years; from 2007 to 2016. The current near-surface velocity is directly derived from sea surface height (ssh), wind stress (τ) and sea surface temperature (sst). Where it is the total of the geostrophic, Ekman-Stommel and thermal wind currents Hausman et al., (2009). The equation is as follows,

$$if\overline{U} = -g\nabla\zeta + \frac{h}{2}\nabla\theta + \frac{\tau - AU'(-h)}{h} \tag{1}$$

where f is coriolis parameter, $\bar{U}$ is for total velocity, g is for gravity acceleration, ζ is for sea surface displacement, h for depth, θ for buoyancy force, τ for wind stress, A for eddy viscosity and U' for vertical shear. These data were collected from various satellite such as TOPEX/Poseidon, Jason-1, Jason-2, ERS 1-2, GFO, ENVISAT ssh anomalies, radiometer SSM/I, QScat and also in situ measurement.

The OSCAR product currents are available on 5 day interval (about 72 time steps per year) with 1/3° resolution (Bonjean., 2002; Zhu et al., 2006). The total velocity is the vertical average over a surface layer thickness of 30 m (Bonjean., 2002; Liu et al., 2014;). The data was downloaded in netcdf data type and processed using Seadas 7.32. And for data display we can used Panoply software.

RESULT AND DISCUSSION

Currents in Northwest Moonson

Currents in northwest moonson shown in Fig2. The velocity of currents starts from 0,0 – 2,6 m/s. The dominant of highest velocity shown in equator area and around of its such as in Sumatra, Borneo, Makassar and Moluca. The movement of currents in northwest moonson start from the South China Sea (The North Andaman Sea) into Java Sea trought the Karimata strait, and continue to move towards the Flores Sea and finally to the Banda Sea with range of velocity of the currents from 0,0 – 2,6 m/s. In the area aroud the Indian Ocean, the currents moves from south Nusa Tenggara toward South Bali the Continued to the west coast of Sumatera, range of velocity in this area from 0,0 – 1,8 m/s. And in the Arafura Sea, shown the weakest velocity of all with the range of velocity from 0,0 – 0,3 m/s.

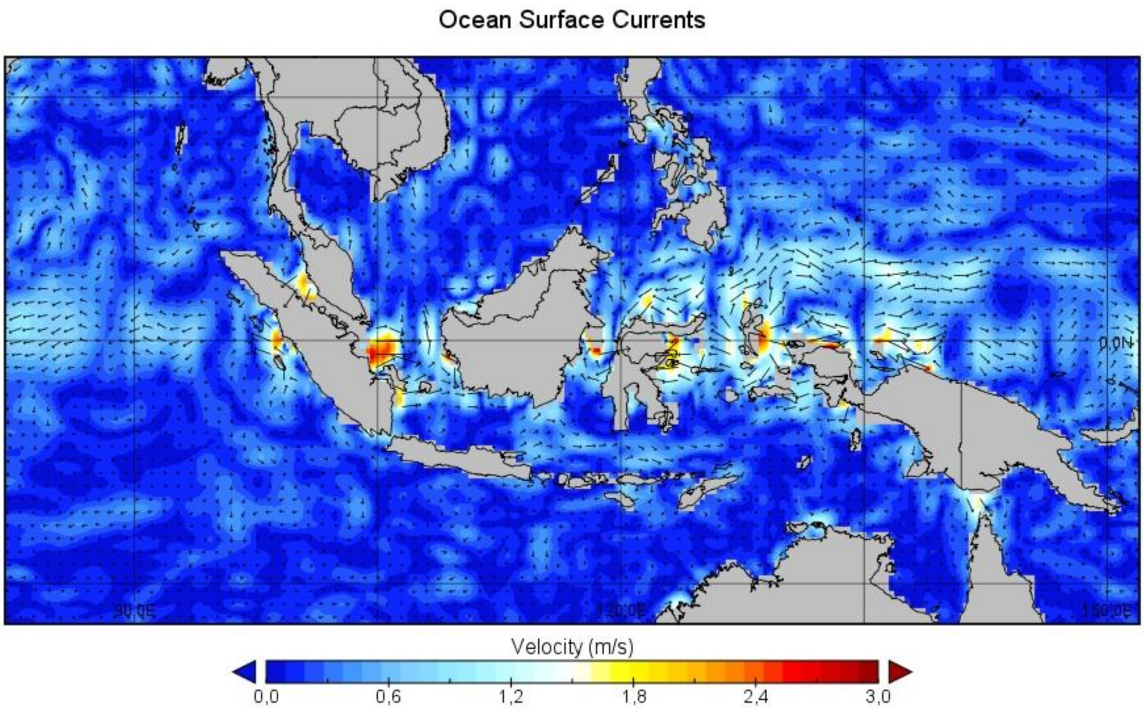

Fig2. Currents in northwest moonson

Currents direction in the region between the islands of Sumatera and Borneo (the Karimata strait) the direction of the currents flow to the south with the velocity range from 0,6 – 2,5 m/s, while in the sea area between Borneo and Celebes islands (Makasar strait) the direction of the currents flow to the north and the velocity range 0,3 – 2,5 m/s, and between Celebes and Molluca (Halmahera strait) the direction of the currents flow to the north and the velocity of the current in this area range 0,9 – 2,4 m/s

Currents in Southeast Moonson

Currents in southeast moonson shown in Fig3. The velocity of currents shown from 0,0 – 2,4 m/s. In this moonson the currents moves from the Banda Sea to the South China Sea, with the velocity range from 0,0 – 2,4 m/s and the direction of currents in this area moves from the east to the west. In the Karimata Strait (between Sumatera and Borneo), the velocity of currents range from 0,9 – 2,4 m/s with the direction of the current flow move from the south to the north. The velocity of the currents in Makassar Strait (the area between Borneo and Celebes) range from 0,0 – 2,1 m/s and the flow direction moves from the south to the north. This condition also occur in Halmahera Strait (the area between Celebes and Molluca), and the velocity range from 0,0 – 2,4 m/s. In the area along south coast of Nusa Tenggara, south coast of Java and west coast of Sumatera shown the velocity of currents from 0,1 – 1,8 m/s. And the velocity of currents in Arafura Sea from 0,0 – 0,4 m/s.

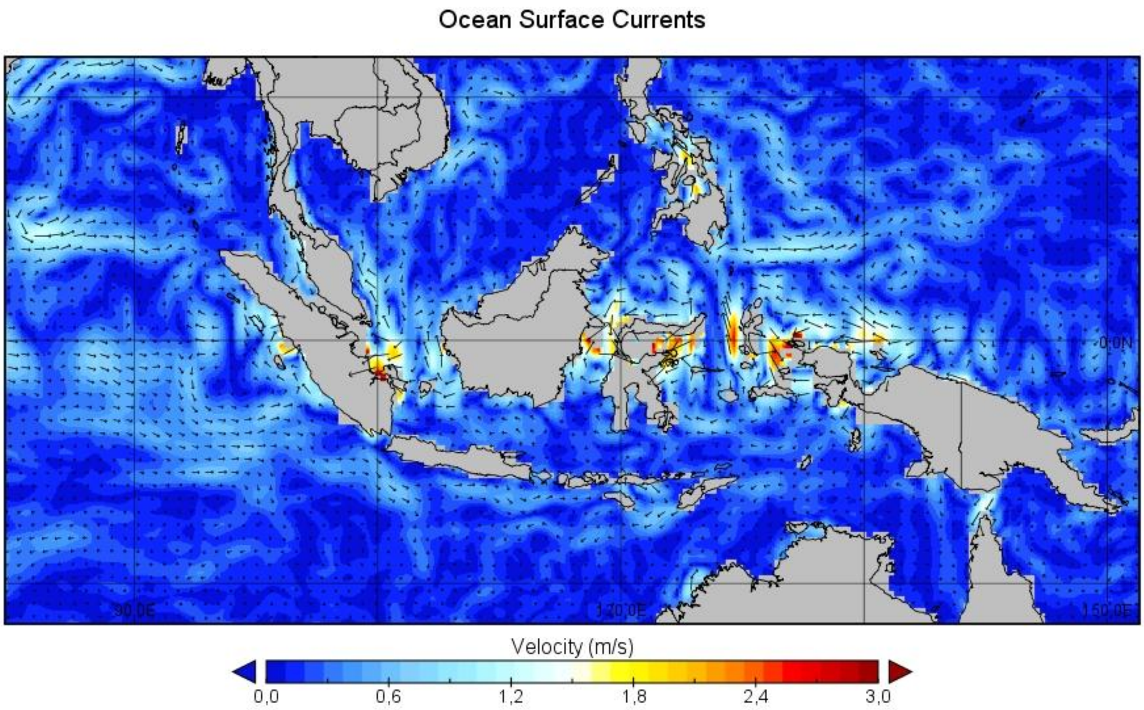

Fig3. Currents in southeast moonson

The surface currents in Indonesian waters are generally influenced by moonson with the different currents patterns in each season and location of the area (Fig2 and 3). In the area around the equator, the currents velocity tends to be higher then in the other location in Indonesia. While the region with the lowest currents velocity is in the Arafura Sea, this area have the weakest velocity during a whole year (Wyrtky, 1961). The direction of the currents between Sumatera and Borneo Islands (Karimata Strait) only in the north and south (Sulaiman et al, 2006), depends on the monnson that occured. At the time of the northwest moonson, the currents velocity along the southern coast of Nusa Tenggara, south Java and western coast of Sumatera in on average lower than at the time of southwest moonson. The currents velocity in the Java Sea is weakens at the time of northwest moonson and will strengthen in the southeast moonson. While the currents velocity in the Flores Sea strengthens at the time of northwest moonson and will weaken in the southeast moonson.

CONCLUSSION

The result shown that the near equator area have the highest velocity and the lowest velocity shown in Arafura Sea during a whole year. When the northwest moonson occured, the currents directions towards east. And in the southeast moonson occured the contrary of northwest moonson.

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REFERENCE

Bird, E. (2007). Coastal Geomorphology : an Introduction. John Wiley & Sons Ltd.. Chichester, West Sussex, UK. 411

Sulaiman, A., Nani, H., Fadli, S., Marina, C.G., Frederik, Muh. Sadly, Retno, A. (2006). Riset dan Teknologi Pemantauan Dinamika Laut Indonesia. Badan Riset Kelautan dan Perikanan, Departemen Kelautan dan Perikanan. Jakarta. 126

Dohan, K. and Nikolai, M. (2010). "Monitoring Ocean Currents With Satellite Sensors." Journal Of The Oceanography Society Vol. 23, No. 4: 94-103.

Zhu, W. H., F. Bonjean., G. Lagerloef, and N. N. Soreide. (2006). Interactive Web Access to Ocean Surface Currents Analyses – Realtime Data. *19th Converence on Climate Variability and Change, 87th AMS Anual Meeting*. San Antonio, Pacific Marine Environmental Laboratory: NOAA: 1-4.

Liu, Y., Robert, H. W., Stefano, V., and Gary, T. M. (2014). "Evaluation of Altimetry-Derived Surface Current Products Using Lagrangian Drifter Trajectories in The Eastern Gulf of Mexico." *Journal of Geophysical Research: Oceans*: 1-16.

Wyrtki, K. (1961). Scientific Results of Marine Investigations of the South China Sea and the Gulf of Thailand 1959-1961. The University of California Scripps Institution of Oceanography. La Jolla, California.

Johnson, E. S., Fabrice Bonjean, Gary S. E. Lagerloef, And John T. Gunn. (2007). “Validation and Error Analysis of OSCAR Sea Surface Currents”. *Journal of Atmospheric And Oceanic Technology:* V:24, 688-701

Hausman J., F. Bonjean, K. Dohan, (2009). Ocean Surface Current Analysis (OSCAR) Third Degree Resolution User’s Handbook. California Institute of Technology contract with the National Aeronautics and Space Administration and the National Oceanic and Atmospheric Administration. California