Effect Of The Monsoon to Sea Surface Temperature In The Java Sea

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Abstract—**Monsoon is the seasonal wind blowing through continents Australia and Asia. Monsoon is one of the main element which influences the weather and climate in some Indonesia areas. Sea Surface Temperature is the water temperature close to the ocean's surface. Sea Surface Temperature is directly influenced by Monsoon. This study is conducted in the Java sea which is located between 2.5 – 10 South Latitude and 105 – 117.5 East Longitude. Moreover, it is located between monsoon wind power regions. This research used the data of zonal wind and meridional wind taken from http://iridl.ldeo.columbia.edu and the data of Sea Surface Temperature in the research areas during 30 years from 1986 to 2015 from https://www.esrl.noaa.gov/psd/data/gridded/tables/sst.html.**
This study aimed to observe the effect of the monsoon on the sea surface temperature changes in the Java seas. The analysis result showed that Monsoon has some effects on the changes of Sea Surface Temperature. The southwestern summer monsoons occur from ApriltoNovember. Besides, the northeastern monsoons occur from Desember to March that will cause the increasing rainfall around the research areas.(*Abstract***)**

Keywords—*Monsoon, Zonal Wind, Meridional Wind, the Java Sea, Sea Surface Temperature* (key words)

I. INTRODUCTION

Monsoon is one of the main wind components whose direction changes periodically and can affect weather and climate changes in almost all areas of Indonesia. The impact of monsoon winds can affect weather and climate changes which has some effects on other sectors such as: transportation, marine, agriculture, and etc. The Java sea is one of the territory in Indonesia which is influenced by the monsoon pattern. The waters around the Java Sea are influenced by two mainstream systems, *Arus Lintas Indonesia* (Arlindo/Indonesian throughflow) and *Arus Monsoon Indonesia* (Armondo/Indonesian Monsoon flow) **(Ilahude and Nontji, 1999).** Monsoon wind circulation is one of the major systems which affects the change of weather and climate in the World **(Li and Zeng, 2002)**. In general, there are two types of monsoon affecting the air mass in the territory of Indonesia. They are Asia Monsoon or well known as Southwestern Monsoon and Australia Monsoon or well known as Northeastern Monsoon. Commonly, most areas in Indonesia experience rainy season during Southwestern Monsoon since this type of monsoon carries the air mass of the Asian continent which contains a lot of water vapor into Indonesian territory. Conversely, at the time of the Northeastern monsoon, most of the regions in Indonesia experience dry season. This is influenced by the dry air (water vapor) from the Australian Continent to Indonesia. Indonesia is one of the archipelago countries in the world having the largest marine areas. Total waters area in Indonesia is more than 5.8 million km^2, which means that Indonesia has an even larger sea area as much as 70% of its total territory. Therefore, weather and climate monsoon in Indonesia is also affected by sea surface temperature (SST). The climate in Java and other major islands represents the maritime climate in Indonesia **(Aldiran, 2008).**

II. DATA AND METHODS

The data used in this research are zonal and meridional wind data for 30 years between 1986 and 2015 obtained from https://iridl.ldeo.columbia.edu and sea surface temperature data for 30 Years from 1986 to 2015 at the Java

Sea whose coordinates 2.5º – 10º South Latitude and 105º - 117.5º East Longitude obtained from https://www.esrl.noaa.gov/psd/data/gridded/tables/sst.html. The data are processed qualitatively to find out whether there was a change of sea surface temperature in Indonesia region caused by changing monsoon patternduring that time.

The researcher used qualitative and descriptive method. Qualitative method was used to calculate the climate data in the form of zonal and meridional wind data in the research area located at 2.5º – 10º South Latitude and 105 º - 117.5 º East longitude. The data were processed statistically using qualitative methods to obtain the average of each month during 30 years period. Then,the researcher calculated the value of α (wind tangential angle).Wind component calculation began by determining the quadrant. 1st Quadrant is when the zonal wind component is positive (+) and the meridional wind component is also positive (+). The wind component is in the 2nd quadrant if the zonal wind component is negative (-) and the meridional wind component is positive (+). The wind component is in the 3rd quadrant if the zonal wind component is negative (-) and the meridional wind component is also negative (-). If the zonal wind component is positive (+) and the meridonal wind component is negative (-) then the wind component is in the 4th quadrant.

This equation is used to obtain the value of α:

$$\alpha = v / u \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(1)$$

Where :

α is the wind direction tangential angle
v is the meridional wind speed
u is the speed of the zonal wind

In addition, we use the previous equation to find β (coefficient of cartesian coordinate) which we can use to find ddd (wind direction) to find the value of β and ddd is used as follows:

$$ddd = 270 - \beta \dots\dots\dots\dots\dots\dots\dots(2)$$

Where :

ddd is the wind direction
β is the cartesian coordinate wind direction (towards)

These different equations are used to calculate β in each different quadrant:

In 1st Quadrant : $\beta = \alpha$, $ddd = 270 - \beta$;............................(3)
In 2nd Quadran: $\beta = 180 - \alpha$, $ddd = 270 - \beta$;.....................(4)
In 3rd Quadrant: $\beta = 180 + \alpha$, $ddd = 270 - \beta$;...................(5)
In 4th Quadrant: $\beta = 360 - \alpha$, $ddd = 270 - \beta$;.....................(6)

After finding the value of ddd (wind direction), the wind direction is presented in the form of windrose every month from January to December using wrplot software. The calculation of Sea Surface Temperature (SST) data from 1986 - 2015 was processed statistically. After that, the researcher calculated the average of monthly Sea Surface Temperature which is then used to be compared with the wind data descriptively.
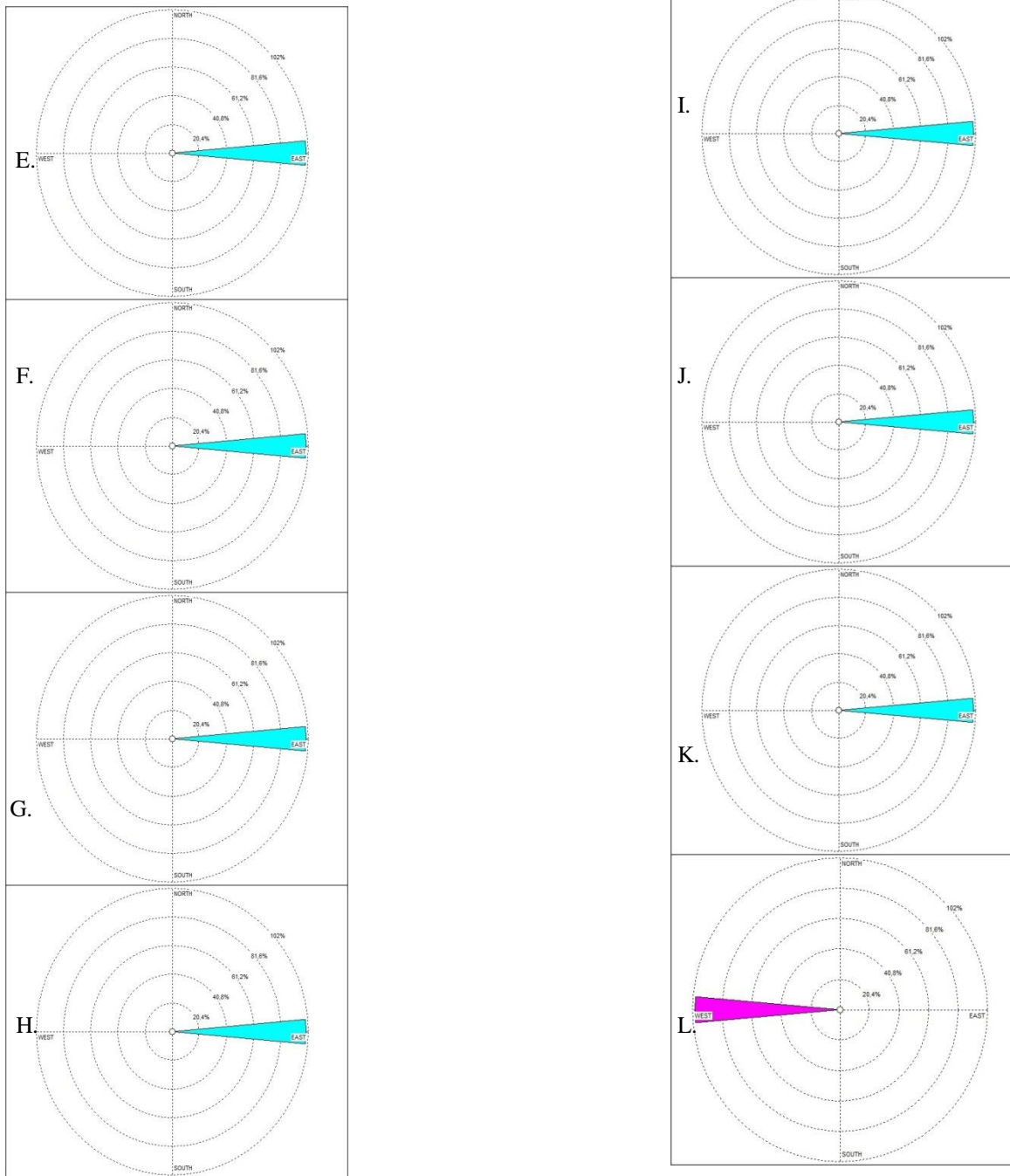
III. RESULT AND DISCUSSION
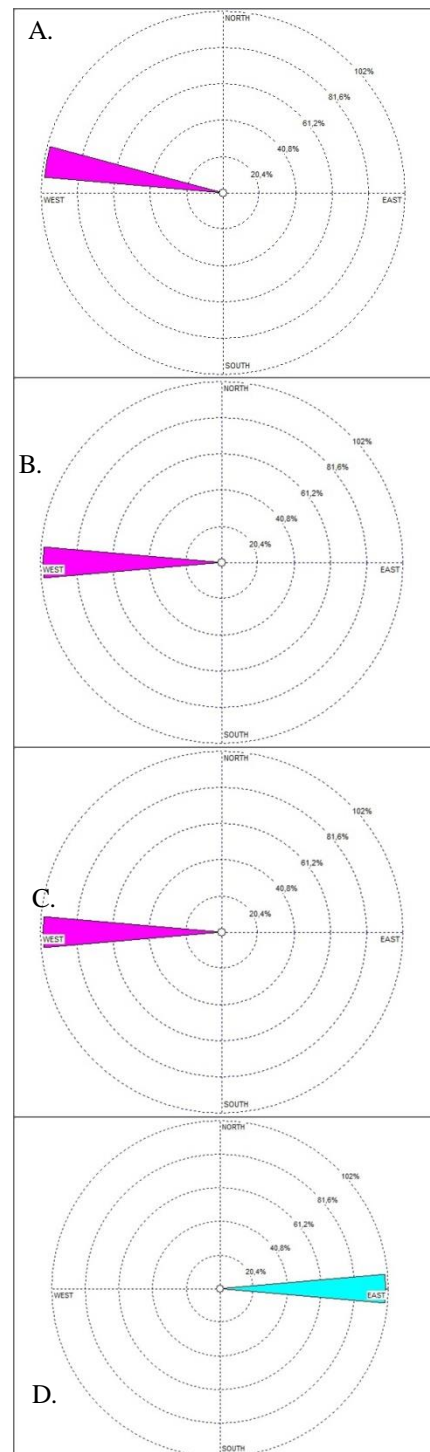
Fig. 1. Monthly Average of Windrose year 1986 to 2015 in Research Areas

a. January, b. February, c. March, d. April, e. May, f. June, g. July, h. August, i. September, j. October, k. November, l. December

Fig. 2. Sea Surface Temperature year 1986 – 2015 in Research Areas.

Based on fig 1, it can be seen that Southwestern monsoon averagely occured in December to March for 30 years from 1986 to 2015. During these months, the air masses from the Asian continent containing high air vapor were carried into the territorial waters of Indonesia. As a result, the Java Sea rain occurred due to the amount of water vapor. When compared with Sea Surface Temperature in December to March, we can conclude that the Sea Front Temperature is relatively warm, above 28,5° Celcius. This warm seas condition also affect the air masses. This is because the air mass moved from SST region which has cooler temperature to the warmer region of the Sea Surface Temperature. Monsoon Australia from 1986 to 2015 occurred in April to December seen from the windrose that has caused wind direction during these months flow from the east. This condition resulted in the dry conditions in the Java Sea area which is due to the air mass coming from the dry Australia region also containing dry water vapor carried into the Java Sea.

Sea Surface Temperature in this month also decreased significantly in August. The value of SST is below 28° celcius. Graph 1 Shows the pattern of Sea Surface Temperature changes from 1986 to 2015. From the fig 2, it can be concluded that the warmest Sea Surface Temperature occurred in April was indicated by the red circle which is the transitional period of Southwestern monsoon to Northeastren monsoon. Following this period, SST tended to decrease in value due to the influence of Australia monsoon. The value of Sea Surface Temperature began to rise again in November indicated by red circle which is the transition from Asia Monsoon (Southwesteren monsoon) to Australia monsoon (Northeastern monsoon). Sea Surface Temperature in Asia Monsoon tended to be warmer than during the period of the Australia Monsoon.

IV. CONCLUSION

Monsoon pattern in the research area for 30 years from 1986 to 2015 in the Java Sea influences the change of SST. West Monsoon begins in December to March and East Monsoon starts from April to November. The west monsoon transition period to the eastern monsoon occurs in April while the transitional monsoon period to West Monsoon occurrs in November.

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