Heat flux aspects on the seasonal variability of sea surface temperature in the Java Sea

by Lilik Maslukah

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ABSTRACT

The seasonal variation of Sea Surface Temperature (SST) in Java Sea shows the semi-annual peaks of SST cooling and warming which is mainly regulated by the speed of the monsoon wind which also semi-annually changes its directions. Nevertheless, how the wind influence the variability of SST in Java Sea was still unstudied. We examined latent and sensible heat flux to link between wind speed and SST variation. Moreover, we also analyzed the radiation budget to complete the heat flux analysis. A set of the remote sensing based data from 2002 to 2016 were used in this study. The parameters were SST, surface wind, latent and sensible heat flux, and shortwave and longwave radiation. We calculated net heat flux by summing all heat flux and radiation parameters. All parameters were composed into monthly climatology. Generally, the SST variation in Java Sea was influenced by heat gain and heat loss. The heat gain was contributed by incoming shortwave radiation with the average value about 210 W/m^2. The heat loss was contributed by latent heat flux i.e., about 105 W/m^2 and outgoing longwave radiation i.e., about 50 W/m^2. The sensible heat flux was negligible since the value was very small i.e., almost 0 W/m^2. Thus, net heat flux in Java Sea was surplus about 55 W/m^2. Since sensible heat flux was very small, the mechanism of wind speed on affecting SST was through latent heat release. The stronger wind, the higher latent heat release, the lower SST will be and vice versa.

***Key words** : SST, Wind speed, Heat flux, Monsoon, Java Sea*

Introduction

Indonesian Archipelago is lying on the confluence of the Eurasian Plate, the Indo-Australian Plate, and the Pacific Plate. Indonesian Archipelago experiences strong seasonal variation caused by monsoon wind which changes its direction every year (Susanto *et al.*, 2006). From May to June southeasterly wind from Australia which carry warm and dry air blow over Indonesian region known as dry season (or South East monsoon season). Conversely, northwesterly wind from Eurasian continent which carry warm and moist air blow the Indonesian region during December-February known as rainy

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season (or North West monsoon season) (Setiawan and Habibie, 2010). This monsoon wind influence the oceanographic conditions within Indonesian Seas in general.

Located at the center of Indonesian Archipelago, Java Sea is one of the path of monsoon wind blowing from Southern Asia to Australia and vice versa (Setiawan and Habibie, 2010). Surrounding by 3 big Islands, i.e., Java, Kalimantan and Sumatra in the southern, northern and western part, Java Sea has relatively shallow bathymetry (mostly less than 100 m) which makes the energy of wind can penetrate deeply to the bottom of the sea (Fig. 1). In the eastern part, Java Sea is bordered by the deep Banda Sea which is known as one path of Indonesian Through flow (Gordon, 2001). This position causes the variabilities of many oceanographic parameters such as salinity, chlorophyll-a and sea surface temperature (SST) in Java Sea are influenced by monsoon (Didier *et al.,* 1997; Hendiarti *et al.*, 2005; Wirasatriya *et al.*, 2018).

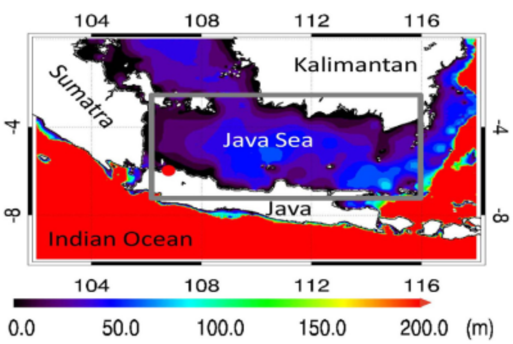

Fig. 1. Bathymetry of Java Sea from 2-Minute Gridded Global Relief Data (ETOPO2v2). Gray box is the area for calculating monthly climatological mean in Fig. 3, 5, 7, 9, 11, 12, 13.

The seasonal variation of SST in Java Sea has been studied by many researchers (e.g., Hendiarti *et al.*, 2005; Wirasatriya *et al.*, 2018; Sachoemar and Yanagi, 2000; Sachoemar *et al.*, 2012; Sachoemar and Yanagi, 2013; Sulistya *et al.*, 2007; Martono, 2016). They indicated that semi-annual peaks of SST cooling and warming in Java Sea is mainly regulated by the speed of the monsoon wind which also semi-annually changes its directions. Nevertheless, none of the previous studies provided the analysis on how the wind speed influence the variability of SST in Java Sea. In the study of very high SST phenomena in the western equatorial Pacific, it has been found that the occurrence of very high SST phenomena is related to the high solar radiation and low wind speed which damps the latent heat flux (Wirasatriya *et al.*, 2015). In the present study, we examined latent and sensible heat flux to link between wind speed and SST variation. Moreover, we also analyzed the radiation budget to complete the heat flux analysis. Air–sea heat flux is important process of the ocean and atmosphere exchange energy in a climate system for keeping the Earth system in a 'balanced' climate state. Sachoemar and Yanagi (2000) has investigated the relation between SST variations in the seas around Java with the heat flux. However, they only used the observed heat flux data from 1 meteorological station in Jakarta which might not represent the actual condition of heat flux in Java Sea. Moreover, the spatial distribution analysis of heat flux also could not be shown in their analysis. Thus, in the present study, the mechanisms on how the heat exchange between ocean and atmosphere in regulating the seasonal SST variability in Java Sea was examined spatial and temporally by using satellite based data.

Materials and Methods

A set of the remote sensing based of oceanic and atmospheric data from 2002 to 2016 were used in this study. For SST, we used National Oceanic and Atmospheric Agency Optimum Interpolation Sea Surface Temperature Version 2 (NOAA_OI_SST_V2) with daily (0.25°×0.25°) temporal (spatial) resolution (Reynolds *et al.*, 2002). OISSTV2 is an analysis constructed SST data by combining observations from different platforms (satellites, ships, buoys) on a regular global grid. Interpolation process were applied to fill in the gaps to produce a spatially complete SST map. The methodology includes bias adjustment of satellite and ship observations (referenced to buoys) to compensate for platform differences and sensor biases. From 2002 to 2011, we used OISSTV2 with combining 2 SST sensors i.e., the Advanced Very High Resolution Radiometer (AVHRR) and Advanced Microwave Scanning Radiometer on the Earth Observing System (AMSR-E). AVHRR is an infrared sensor that can make observations at relatively high resolution but cannot observe through clouds. Conversely, AMSR-E is a microwave instruments that can measure SSTs in most weather conditions (except heavy rain) but the spatial resolution is much lower than infrared instrument. Unfortunately, in October 2011 the AMSR-E lost its full functionality. Thus from 2011 to 2016, we used OISSTV2 which was only provided by AVHRR measurement.

For surface wind data, we used daily The Cross-Calibrated Multi-Platform (CCMP) gridded surface vector winds with spatial resolution 0.25°×0.25° (Atlas *et al.*, 2011). This product is produced using satellite, moored buoy, and model wind data, and as such, are considered to be a Level-3 ocean vector wind analysis product. The V2 CCMP processing now combines Version-7 Remote Sensing System radiometer wind speeds consists of Quik SCAT and ASCAT scatterometer wind vectors, moored buoy wind data, and ERA-Interim model wind fields using a Variational Analysis Method.

For latent and sensible heat flux data, we used the daily Objectively Analyzed Air-sea Flux (OAFlux) with the grid interval of 1°×1° (Yu and Weller, 2007). The OA Flux project applies objective analysis approach from satellites and Numerical Weather Prediction data sources to develop the enhanced global flux fields. Such process reduces error in input data sources and produces an estimate heat flux with the minimum error variance. For surface radiation (i.e., shortwave radiation and longwave radiation), we used data from International Satellite Cloud Climatology Project (ISCCP) (Zhang et.al., 2004) which is also available for distribution along with the OAFlux products. Unfortunately, the available period of surface radiation data is only until 2009. Thus, our analysis only used 8 years data for surface radiation (i.e., 2002-2009).

To investigate the seasonal variation of SST and other parameters, we constructed monthly climatology data. First, all parameters were composited into monthly means and then used to derive monthly climatologies by using this formula (Wirasatriya *et al.*, 2018) :

$$\bar{X}(x,y) = \frac{1}{n}\sum_{i=1}^{n} xi\,(x,y,t) \quad .. (1)$$

where $\bar{X}(x,y)$ is monthly mean value or monthly climatology value at position (x,y), $xi(x,y,t)$ is ith value of the data at (x,y) position and time t. Moreover, n is number of data in 1 month and number of monthly data in 1 period of climatology (i.e., from 2002 to 2016 = 16 data) for monthly calculation and monthly climatology calculation respectively. Pixel *xi* is excluded in the calculation if it is a gap.

We also calculated the net heat flux by summing all heat flux and radiation parameters, i.e.,

$$Q_{net} = Q_{SW}+Q_{LW}+Q_{SH}+Q_{LH} \quad .. (2)$$

Where Q_{net}, Q_{SW}, Q_{LW}, Q_{SH}, and Q_{LH} are net heat flux, solar radiation, longwave radiation, sensible heat flux and latent heat flux, respectively. Positive heat flux means downward flux.

Results

Seasonal variation of SST and surface wind in Java Sea

The seasonal variation of SST in Java Sea is shown in the monthly climatology map in Fig. 2. There are 2 peaks of low SST in Java Sea i.e., in February and August. During north western (south eastern) monsoon, the SST cooling appeared in the north western (eastern) corner of Java Sea, dispersed south eastwardly (westwardly) and peaked in February (August). Conversely, during transition season, warm SST spread over the Java Sea. Time series graph of mean SST and mean wind speed in the sampling box area shown in Fig. 3 shows the relation between them. The minimum (maximum) mean SST in Java Sea occurred in February and August (May and November) i.e., 28.45°C and 28.33C (29.65°C and 29.22°C), respectively. The SST decreased as wind speed increased and vice versa. The correlation was about -0.6 which indicated the strong dependence of SST on wind speed variation. This relation supports the previous studies which also showed the same tendencies (e.g., Wirasatriya *et al.*, 2018; Sachoemar and Yanagi, 2000; Sachoemar *et al.*, 2012; Sachoemar and Yanagi, 2013). The physical process behind this relation is described in the next sub section.

Relation between wind speed and heat flux

To investigate the mechanisms on how wind speed influence SST in Java Sea, Fig. 4 (6) shows the latent (sensible) heat map overlaid with surface wind vector. Furthermore, their time series graphs are shown in Fig. 5 and 7. Latent heat is thermal energy released or absorbed by the sea surface which is determined by wind speed and the difference of specific humidity at the sea surface and 10 m above (Fairall *et al.*, 1996; Fairall *et al.*, 2003). Figure 4 shows that the distribution of latent heat in Java Sea had positive value throughout year which indicated the latent heat release. The distribution of latent heat re-

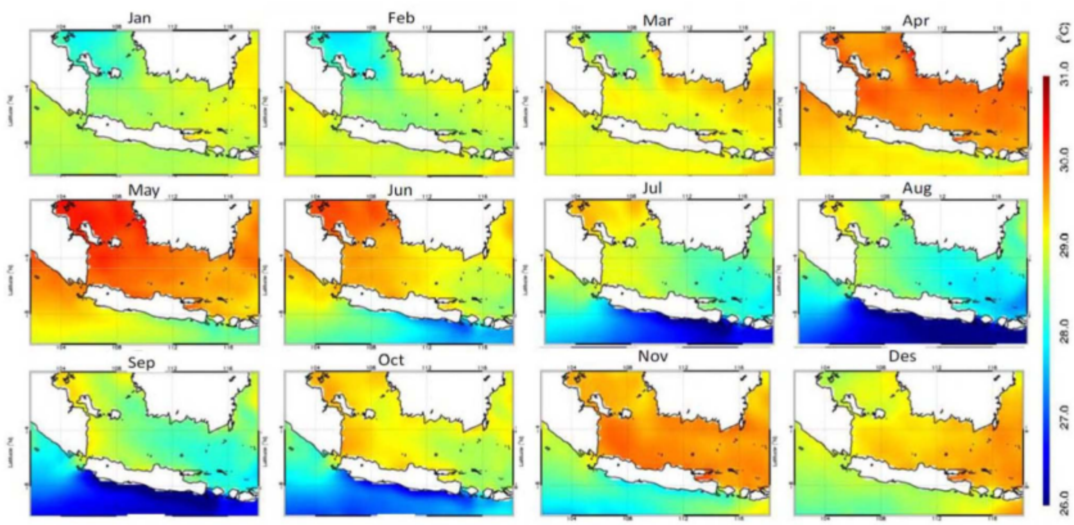

Fig. 2. Monthly climatology of SST in Java Sea

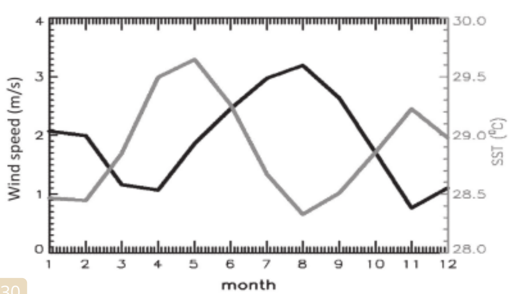

Fig. 3. Time series of mean SST and wind speed in the gray box shown in Fig. 1.

lease corresponded to the distribution of wind speed. In the area where wind speed was strong, latent heat release was also high. Moreover, Fig. 5 shows that the variation of mean latent heat release is closely related to the variation of wind speed. The maximum (minimum) latent heat release was about 190 (90) W/m^2 in August (November) which was coincided with the maximum (minimum) wind speed i.e., about 3.2 (0.8) m/s. It is also shows that the maximum peak of latent heat release occurred during South East monsoon than during North West monsoon since the wind speed blew during South east Monsoon was stronger than during North West monsoon.

Different with latent heat flux, sensible heat flux is determined by wind speed and the temperature different between sea surface and 10 m above (Fairall, 1996; Fairall, 2003). Fig 6 shows that the distribution of sensible heat flux in Java Sea was not always positive. In some area and period, negative sensible heat flux occurred. This means that Java Sea did not always release heat through sensible heat flux mechanisms. Since sensible heat flux is determined by the difference between air temperature near sea surface and SST, SST in Java Sea did not always higher than the air temperature near the sea surface. The relation of mean sensible heat flux in Java Sea with the wind speed is clearly shown in Fig. 7. From January to July, the variation of sensible heat flux followed the variation of wind speed. Conversely, from August to December, the decrease of wind speed were not followed by the sensible heat flux. This may be caused by the large difference between SST and surface air temperature. Nevertheless, the range of sensible heat flux in Java Sea was only between 7 W/m^2 and 11 W/m^2 which was not comparable to the latent heat variation. Therefore, latent heat flux played an important role in regulating heat release controlled by the wind speed in Java Sea.

Shortwave radiation and longwave radiation

Shortwave radiation is solar energy down to the earth surface as the ultraviolet, visible light and near infrared radiation. The distribution of incoming shortwave radiation is shown in Fig 8. There were 2 peaks of incoming shortwave radiation which

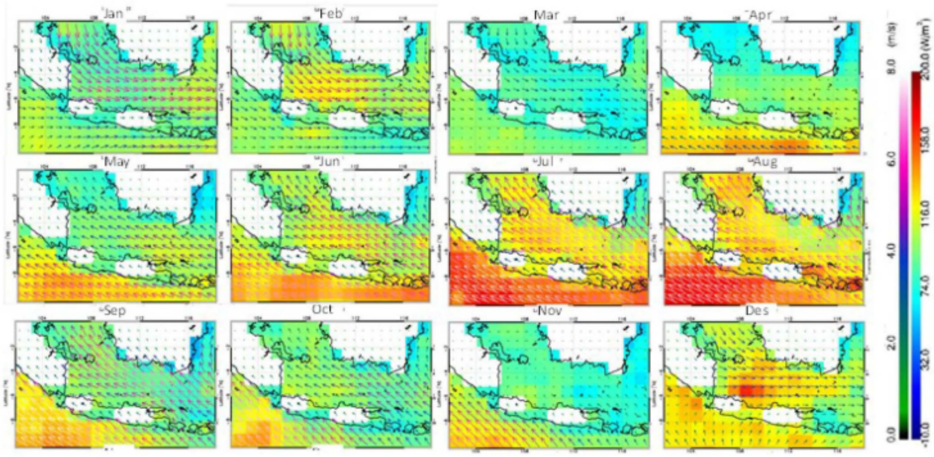

Fig. 4. Monthly climatologyof latent heat flux overlaid with surface wind vector in Java Sea. Positive (negative) flux means heat gain (loss).

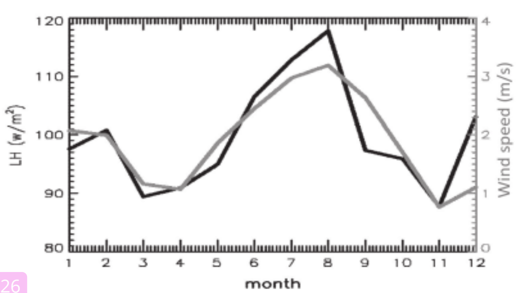

Fig. 5. Time series of mean latent heat flux and wind speed in the gray box shown in Fig. 1.

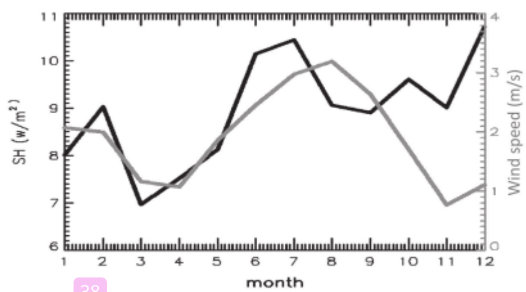

Fig. 7. Time series of mean sensible heat flux and wind speed in the gray box shown in Fig. 1.

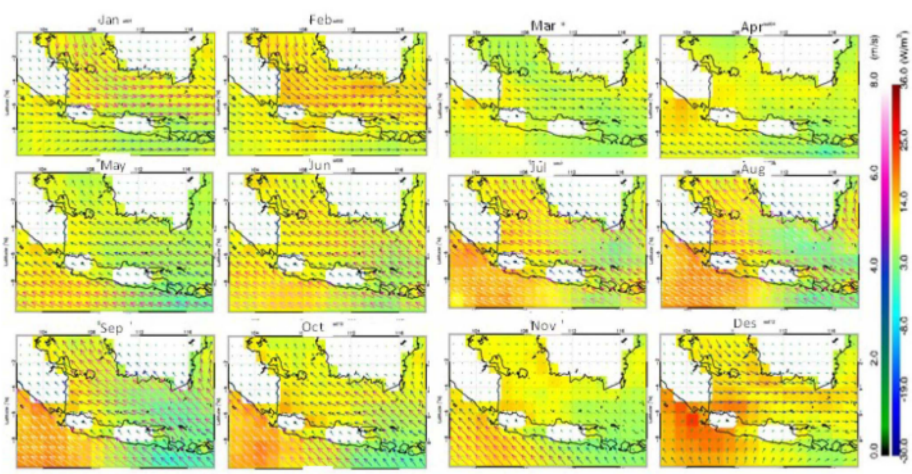

Fig. 6. Monthly climatology of sensible heat flux overlaid with surface wind vector in Java Sea. Positive (negative) flux means heat gain (loss).

reached 300 W/m[2] i.e., in March and September in Java Sea which is located near the equator. This was due to the solar equinox events which occur every March and September. When the sun passes the equator, shortwave radiation reach its maximum. The high amount of incoming shortwave radiation indicated that the shortwave radiation was the heat source in Java Sea. However, the time series graph in Fig. 9 shows that the variation of shortwave radiation did not follow the variation of SST. In July when shortwave radiation started to increase was not followed by the increase of SST. This may be related to the variation of outgoing longwave radiation.

Outgoing longwave radiation is the energy radiating from the earth surface to the space as infrared radiation at low energy. The existence of outgoing longwave radiation balance the incoming heat from shortwave radiation which keeping the warm temperature of earth's surface. Figure 10 shows the distribution of outgoing longwave radiation in Java Sea and Fig. 11 is its time series graph. The peak of outgoing longwave radiation occurred annually from June to October. This may balance the peak of incoming shortwave radiation in this period so that the increasing incoming shortwave radiation were not followed by the increasing SST.

Net heat flux

The resultant of heat flux influence for the variation of SST in Java Sea is shown in net heat flux which is the sum of all heat and radiation flux. The climatological mean of the net heat flux was about positive 55 W/m[2]. The correlation analysis between net heat flux and SST is only 0.02.

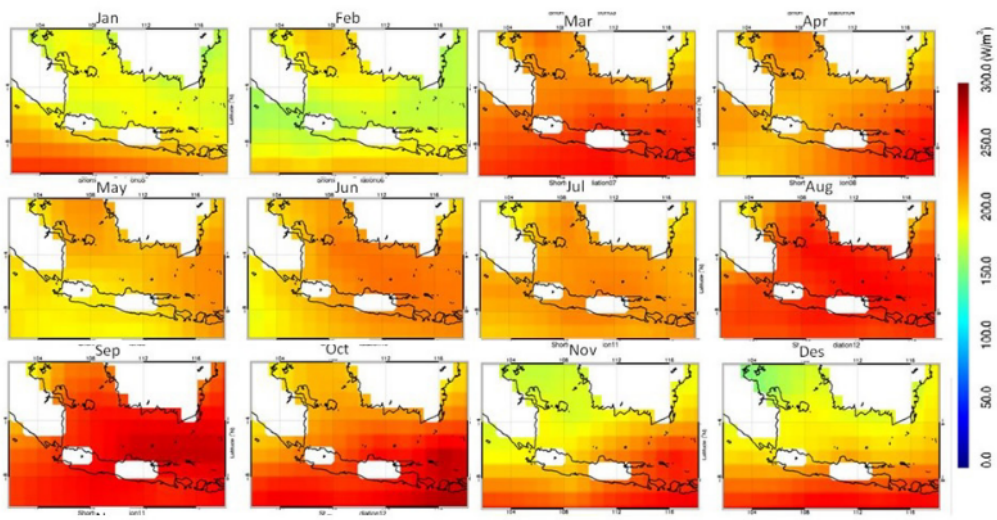

Fig. 8. Monthly climatology of incoming shortwave radiation in Java Sea.

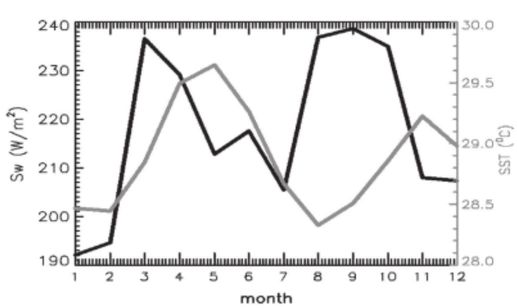

Fig. 9. Time series of mean incoming shortwave radiation and SST in the gray box shown in Fig. 1.

In Fig. 12, we can see that the variation of SST followed the variation of net heat flux with 2 months lag phase. The 2 months lag correlation were 0.77 which denoted the strong correlation between them. The variation of net heat flux mainly was contributed by the variation of shortwave radiation which made the lag correlation with the SST variation. As shown in Fig. 5 the first peak of shortwave radiation occurred in March, the same period with the net heat flux and 2 months earlier from the

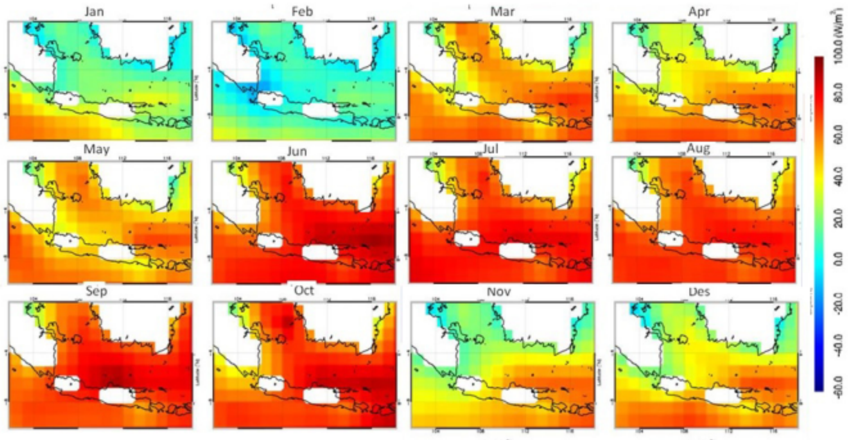

Fig. 10. Monthly climatology of outgoing longwave radiation in Java Sea

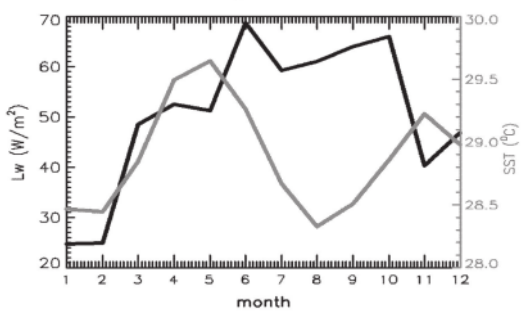

Fig. 11. Time series of mean outgoing longwave radiation and SST in the gray box shown in Fig. 1.

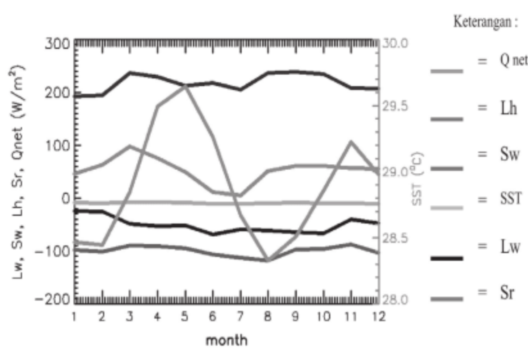

Fig. 13. Time series of all heat fluxes parameters and SST in Java Sea in the gray box shown in Fig.1.

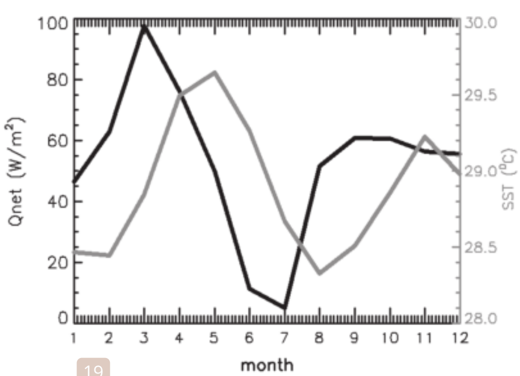

Fig. 12. Time series of mean net heat flux and SST in the gray box shown in Fig. 1. Positive (negative) heat flux means heat gain (loss).

first peak of SST. In the second peak, i.e. September, the high incoming shortwave radiation was bit balanced by high outgoing longwave radiation, which made the second peak of SST (i.e., in November, also 2 months later from the second peak of shortwave radiation) was lower than its first peak.

Discussion

This study revealed that the mechanism of wind speed on affecting SST was through latent heat release. The stronger wind speed, the more latent heat release and the higher SST would be. On the other hand, shortwave radiation had low and lag correlation with the SST. Thus, with enough heat gain from shortwave radiation, wind speed had more direct impact on the variability of SST in Java Sea than shortwave radiation its shelf. This result is similar with the mechanisms of very high SST called Hot Event in the western equatorial Pacific (Wirasatriya *et al.*, 2015). Under the condition of high shortwave radiation, wind speed plays important role to the occurrence of the Hot Event in the western equatorial Pacific. For the global equatorial seas, Kumar *et al.*, (2017) has found that under the increasing SST from 25°C to 28°C, latent heat release is influenced by the contradictory increasing wind speed and decreasing vertical humidity gradient which makes the variation of latent heat release is small. In Java Sea, we found that, the variability of latent heat release agrees well with the wind speed. This indicates that the vertical humidity gradient is too small to influence the latent heat release. Furthermore, this result is arguing (Sachoemar and Yanagi, 2000). Sachoemar and Yanagi, (2000) compared the mechanisms of SST variability in Java Sea and the seas southern coast of Java. They stated the variability of SST in Java Sea was mainly governed by the net heat flux while in the seas southern coast of Java was influenced by monsoon wind resulting the annual variation. In the present study, we agree that the seasonal variability in Java Sea is governed by the variability of net heat flux, but the variability of net heat flux is strongly influenced by the variability of monsoon wind by controlling the latent heat flux. Thus, we cannot separate between net heat flux and the variability of wind (Sachoemar and Yanagi, 2000) only used the observed heat flux from meteorological station in Jakarta. Thus, it cannot be used for analyzing the SST variability in the seas southern coast of Java which may have very different characteristic with Java Sea. For the global tropical ocean.

Moreover we also found the surplus heat gain in Java Sea which may maintain the warm sea temperature in Java Sea. The surplus net heat gain did not cause unlimitedly increasing SST. The surplus net heat gain in the sea surface may also be transported to the water column through mixing mechanisms by wind, creating warm mixed layer. The mechanisms of the mixed layer formation have been widely known as shown systematically by Marshall and Plumb (2008) involving radiative flux, mass flux and momentum flux. The reduced surface heat gain transported to the mixed layer also may cause the correlation between SST and net heat gain was resting for 2 months. However, in this study we did not deal with vertical profile of sea parameters which can be used for investigating how the heat was transported to the water column. This problem is left for future study.

Conclusion

The heat flux aspects on the seasonal variability of SST in Java Sea has been studied by using remote sensing based data. The conclusions are summarized in Fig. 13 as follows:

1. The SST variation in Java Sea was influenced by heat gain and heat loss.
2. The heat gain was contributed by incoming shortwave radiation with the average value about 210 W/m^2.
3. The heat loss was contributed by latent heat flux i.e., about 105 W/m^2 and outgoing longwave radiation i.e., about 50 W/m^2.
4. The sensible heat flux was negligible since the value was very small i.e., almost 0 W/m^2.
5. The net heat flux in Java Sea was surplus about 55 W/m^2. This result has similar pattern with the observed heat flux in meteorological station in Jakarta with the smaller value as shown by Sachoemar and Yanagi (2000).
6. The net heat flux variability had high correlation with SST variability with 2 months lag.

Acknowledgement

NOAA_OI_SST_V2 data is provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their Web site at https://www.esrl.noaa.gov/psd/. CCMP Version-2.0 vector wind analyses are produced by Remote Sensing Systems. Data are available at www.remss.com. The global ocean heat flux products were provided by the WHOI OAFlux project (http://oaflux.whoi.edu), funded by the NOAA Climate Observations and Monitoring (COM) program. ISCCP-FD data were provided courtesy of the NASA Goddard Institute for Space Studies. In addition, we would like thanks to Diponegoro University that funded this research under the scheme of International Publication Research 2016-2018, contract No 1052-24/UN7.5.1/PG/2016; 276/22/UN7.5.1/PG/2017; 474-78/UN7.P4.3/PP/2018.

References

Atlas, R., Hoffman, R.N., Ardizzone, J., Leidner, S.M., Jusem, J.C., Smith, D.K. and Gombos, D. 2011. A

Cross-calibrated, multiplatform ocean surface wind velocity product for meteorological and oceanographic applications. *Bull. Amer. Meteor. Soc.* 92 : 157-174.

Didier, P., Pascal, C. and Nugroho, D. 1997. The seasonal variation of salinity in the Java Sea. *Proceedings of acoustics seminar AKUSTIKAN*2 : 29-42.

Fairall, C.W., Bradley, E. F., Hare, J. E., Grachev, A. A. and Edson, J. B. 2003. Bulk parameterization of air–sea fluxes: updates and verification for the COARE algorithm. *J. Climate.* 16 : 571-591.

Fairall, C.W., Bradley, E. F., Rogers, D. P., Edson, J. B. and Young, G. S. 1996. Bulk parameterization of air–sea fluxes for tropical ocean-global atmosphere coupled-ocean atmosphere response experiment. *J. Geophys. Res.* 101 : 3747–3764.

Gordon, A.L. 2001. Interocean exchange. In: Siedler, G., Church, J., Gould, J. (Eds.), *Ocean Circulation and Climate*. Academic Press, San Diego, 640pp.

Hendiarti, N., Suwarso, Aldrian, E., Amri, K., Andiastuti, R., Sachoemar, S.I. and Wahyono, I. B. 2005Seasonal variation of pelagic fish catch around Java. *Oceanography* 18(4) : 112-123.

Kumar, B.P., Cronin, M.F., Joseph, S., Ravichandran, M. and Sureshkumar, N. 2017. Latent heat flux sensitivity to sea surface temperature: regional perspectives. *J. Clim.*30 : 129-143.

Marshall, J. and Plumb, R.A. 2008. *Atmosphere, Ocean and Climate Dynamics: An Introductory Text*. Elsevier Academic Press, Cambridge, Massachusetts, p.175.

Martono. 2016. Seasonal and interannual variations of sea surface temperature in the Indonesian Waters. *Forum Geografi*. 30 (2) : 120-129.

Reynolds, R.W., Rayner, N.A., Smith, T.M., Stokes, D.C. and Wang, W. 2002. An improved in situ and satellite SST analysis for climate. *J. Climate.*15 : 1609-1625.

Sachoemar, S. I. and Yanagi, T. 2000. Seasonal variation in sea surface temperature around Java derived from NOAA AVHRR. *La Mer*38 : 65-75.

Sachoemar, S.I. and Yanagi, T. 2013. *Temporal and Spatial Variability of Sea Surface Temperature within Indonesian Regions Revealed by Satellite Data*. Reports of Research Institute for Applied Mechanics. Kyushu University. 145 : 37-41.

Sachoemar, S.I., Yanagi, T. and Aliah, R.S. 2012. Variability of sea surface chlorophyll-a, temperature and fish catch within Indonesian Region revealed by satellite data. *Mar. Res. Indonesia* 37 (2) : 75-87.

Setiawan, R.Y. and Habibi, A. 2010. SST cooling in the Indonesian Seas. *Indonesian J. Mar. Sci.* 15 (1) : 42-46.

Sulistya, W., Hartoko, A. and Prayitna, S.B. 2007. The characteristics and variability of sea surface temperature in Java Sea. *Remote Sensing and Earth Sciences*. 4 : 85-93.

Susanto, R.D., Moore, T.S. and Marra, J. 2006. Ocean color variability in the Indonesian Seas during the seawifs era. *Geochem. Geophys. Geosyst.* 7(5) : 1-16.

Wirasatriya, A., Kawamura, H., Shimada, T. and Hosoda, K. 2015. Climatology of hot events in the Western Equatorial Pacific. *J. Oceanogr.* 71 : 77-90.

Wirasatriya, A., Setiawan, R.Y., and Subardjo, P. 2017. The effect of ENSO on the variability of chlorophyll-a and sea surface temperature in the Maluku Sea. *IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens.* (JSTARS). 10(12): 5513-5518.

Yu, L. and Weller, R.A. 2007. Objectively analyzed air-sea heat fluxes for the global oce-free oceans (1981–2005). *Bull. Ameri. Meteor. Soc.* 88 : 527–539.

Zhang, Y-C., Rossow, W.B., Lacis, A.A., Oinas, V., and Mishchenko, M.I. 2004. Calculation of radiative fluxes from the surface to top of atmosphere based on ISCCP and other global data sets: refinements of the radiative transfer model and the input data. *J. Geophys. Res.* 109 : 1-27.0

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---

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9