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Effects of Dipole Mode Event on the Rainfall Variability over the Southern and Western Part of Sumatera Island, Indonesia

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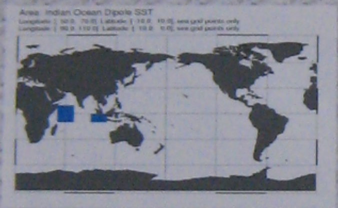
Abstract

The rainfall variability over the Southern and Western of Sumatera Island, Indonesia associated with the Dipole Mode (DM) event has been analyzed for the period of 1980-1999. This study is based on the monthly mean of rainfall data, Dipole Mode Index (DMI), Sea Surface Temperature (SST), and Outgoing Longwave Radiation (OLR).

By applying the spectral analysis (Fast Fourier Transform, FFT), the pre-dominancy peak of rainfall and DMI data oscillation can be identified. The pre-dominancy peak oscillation derived from rainfall data are Semi-Annual Oscillation (SAO) for Bukit Tinggi, Maninjau, and Sicincin, and Annual Oscillation (AO) for Padang Panjang, Padang, Batu Sangkar, Solok, Tabing, Bengkulu, Kotabumi, Jambi and Palembang. While, the other notable oscillations are interannual oscillation, which is found also from both rainfall and DMI data. This similar oscillation indicates that Dipole Mode can be related to the rainfall over Southern and Western Sumatera. The detailed analysis shows that the DMI oscillation is closed to 1.5 to 3 years.

Generally, the Dipole Mode event is influential to the rainfall in Southern and Western Sumatera. When DM (+) occurs, that areas receive less rainfall than usual condition, especially during the JJA (June-July-August) and SON (September-October-November) season. Conversely, when DM (-) occurs, the amount of rainfall is more than usual condition. During JJA and SON, rainfall are significantly correlated with DM event. Compared by DM (-), DM (+) looks more giving a significant influence to the rainfall in both areas.

1. Introduction



Generally, rainfall in Indonesia is influently dominated by some phenomena such as Asia-Australia Monsoon System, Southern Oscillation, East-West circulation (Walker Circulation), North-South circulation (Hadley Circulation) and another circulation, caused by local influence (Mcbride, 2002).

Besides those phenomena, many researchers are now interested in a Phenomena in Indian Ocean region, called **INDIAN OCEAN DIPOLE MODE (IODM).**

DIPOLE MODE → Coupled ocean-atmosphere phenomena in the Indian Ocean. It is normally characterized by anomalies cooling of Sea Surface Temperature (SST) in the south Eastern Equatorial Indian Ocean and anomalies warming of SST in the Western Equatorial Indian (Yamagata, 2001).

2. Data and Method of Analysis

2.1. Data Used

a. Dipole Mode Index from which is defined as the SST anomaly between Western part and Eastern of Indian Ocean agian Barat (50E-70E; 10S-10N) and (90E-110E; 10S-eq), respectively.
b. The monthly of SST, OLR, and precipitation globally during Januari 1980 to December 1999 that taken from NCEP/NCAR Reanalysis (http://www.cdc.noaa.gov).
c. The monthly of rainfall obervation over 12 and 8 station at Western and Southern part of Sumatera Island in the same time of period observation. Those data are taken from BMG.

2.2. Method of Analysis

a. Estimate the rainfall percentage in the years of DM event during 20 years toward normal years.
b. Cross-correlation analysis to estimate the elationship between the results of observation from two varian (bivariate) at a certain population.
c. Composit analysis of SST, SLP, OLR, and rainfall anomaly.

3. Premilinary Results

3.1. Percentage of seasonal rainfall in Western Sumatera (8 Station) and Southern Sumatera (5 station) in DM(+) and DM(-), where, under normal condition (<85%), normal (85%-115%) and above normal (>85%).

2. Correlation between SST, SLP, and rainfall anomaly in Western (**Fig 3.a and 3.b**) and Southern Sumatera (**Fig 4.a and 4.b**) for DM(+) and DM(-).

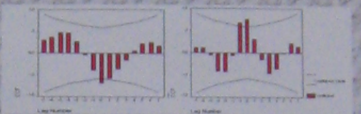


Fig.3.a r=-0,680 for DM(+) **Fig.3.b r=0,759 for DM(-)**

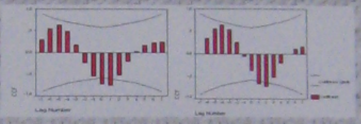


Fig.4.a r=-0,749 for DM(+) **Fig.4.b r=0,729 for DM(-)**

3. Composite SST, SLP, OLR, and rainfall anomaly (JJA, SON) between Sumatera and Indian Ocean for the years DM(+) and DM(-) event.

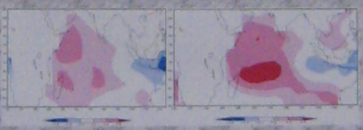


Fig.5.a. Composite SST anomaly (JJA,SON) for DM(+). Values are in °C.

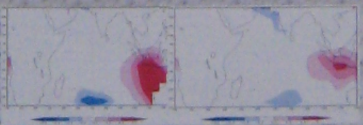


Fig.5.b. Composite SST anomaly (JJA,SON) for DM(-). Values are in °C.

Fig.6.a. Composite SLP anomaly (JJA,SON) for DM(+). Values are in mb.

Fig.6.a. Composite SLP anomaly (JJA,SON) for DM(+). Values are in mb.

Fig.7.a. Composite OLR anomaly (JJA,SON) for DM(+). Values are in w/m2.

Fig.7.b. Composite OLR anomaly (JJA,SON) for DM(-). Values are in w/m2.

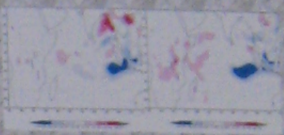


Fig.8.a. Composite Rainfall anomaly (JJA,SON) for DM(+). Values are in mm / month.

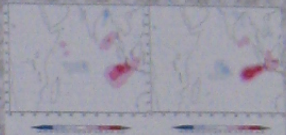


Fig.8.b. Composite Rainfall anomaly JJA,SON) for DM(-). Values are in mm / month.

4. Discussion

From those gigures we can see that for DM(+) especially on JJA and SON, the average rainfall is under normal condition, otherwise for DM(-) the average rainfall is above normal condition. This condition is consistent with the picture of composite rainfall anomaly (fig.8) in Sumatera.

SST has significant correlation with rainfall anomaly (fig.3 and fig.4) for DM(+) and DM(-), while SLP has significant correlation only with rainfall anomaly for DM(-) especially in Western Sumatera. OLR has a small correlation with rainfall anomaly, we suspect that center of convections are little far away from West and Southern part of Sumatera Island.

5. Conclusion

This study mainly concerned to investigate effects of Dipole Mode event to the rainfall variability over Western and Southern part of Sumatera Island, Indonesia. Generally, the Dipole Mode event is influential to the rainfall in Southern and Western Sumatera. When DM (+) occurs, that areas receive less rainfall than usual condition, especially during the JJA (June-July-August) and SON (September-October-November) season. Conversely, when DM (-) occurs, the amount of rainfall is more than usual condition. During JJA and SON, rainfall are significantly correlated with DM event. Compared by DM (-), DM (+) looks more giving a significant influence to the rainfall in both areas.

References

Saji NH, B. N. Goswami, P. N. Vinayachandran and T. Yamagata, 1999. *A Dipole Mode in The Tropical Indian Ocean*, in Macmillan Magazines ltd, Nature, Vol 401. http://iprc.soest.hawaii.edu/~saji