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STUDY OF MJO OVER HYDERABAD USING ATMOSPHERIC DATA OF RADIOSONDE

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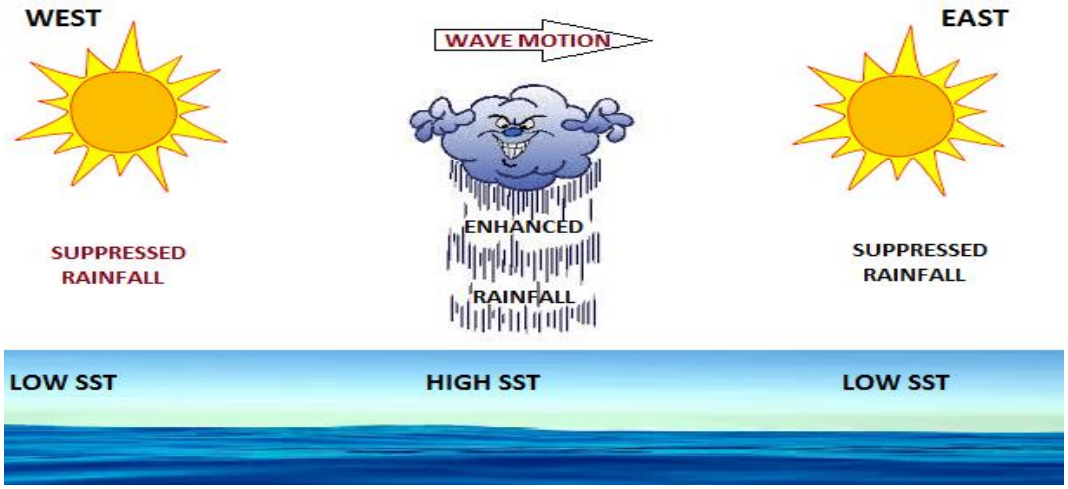
Abstract— **Madden Julian Oscillation (MJO) is defined as eastwards propagation of rainfall from the Indian Ocean to the western pacific ocean with an average velocity of 5ms^{-1}. To study the existence of such oscillation over a low latitude station Hyderabad (17.366°Nand 78.476°E) the parameters pressure and precipitation are chosen. Pressure and precipitations values are evaluated from the Radiosonde data of Hyderabad station, collected from the Integrated Global Radiosonde Archive, NOAA. The missing values of data are interpolated by using Matlab tools. Finally, the variations of pressure and precipitation values are plotted with respect to time in days. Hence it is found that the pressure and precipitation are fluctuating with the frequency of MJO (frequency of MJO is 7 to 8 per annum) which is clear evidence of the existence of MJO over Hyderabad. This research is very useful for weather forecasting, air traffic control, and the agriculture sector, etc.**

Keywords— **pressure, precipitation, Radiosonde, Madden Julian Oscillation**

I. INTRODUCTION

In the year 1976 the Paul Julian and Ronald madden was analyzing the zonal wind velocity over Singapore region they observed a new phenomenon in the atmosphere and named it as madden Julian oscillation[1] (MJO). It is the largest intraseasonal variability[2] (28-90days) in the tropical atmosphere. It is defined[1][2] as eastwards propagation rainfall from the Indian Ocean to the west Pacific Ocean with an average velocity of 5ms^{-1} It is also defined as enhanced rainfall in the Indian ocean and suppressed rainfall in the west pacific ocean or vice versa. Depend upon the time period the MJO is classified into two types short period MJO[3] that lasts up to 50days and long period MJO[3] that is 50 to 90days. This phenomenon occurs only in the tropical atmosphere due to the increase in sea surface temperature (SST) above 28-degree centigrade[4]. Due increase in SST low pressure is created results in the formation of clouds which in turn causing the rainfall.



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II. METHODOLOGY

To study MJO activity over Hyderabad a low latitude station, the Radiosonde[5] data are collected from 01 January 2018 to 31 December 2018 from the Integrated Global Radiosonde Archive, NOAA[5]. Every day at 00Z and 12Z The balloon with the payload attached at the bottom launching from the Hyderabad international airport the balloon having sensors to measure the values of relative humidity, temperature, pressure, wind velocity, and direction. The pressure and precipitation data values are extracted from it. the pressure altitude values of 200, 400, 600 & 800hpa evaluated and the missing data is interpolated by cubic spline interpolation method. Both pressure and precipitation values are plotted with respect to time in days of entire year divide into four quarters (first quarter 0-90days, second quarter 91-180days, third quarter 181-270 days and fourth quarter 271-365 days.

III. EXPERIMENT AND RESULT

MJO is defining as the propagation of rainfall from the Indian Ocean to the western pacific ocean with an average velocity of 5m/s and low pressure causing rainfall. To study MJO pressure variation is studied. The clouds are formed between the 800 to 200hpa pressure[6]. This pressure range is divided into four parts (800, 600, 400 & 200) because clouds are formed anywhere in between this range. Hence, to track low pressure the pressure 800, 600, 400 and 200hpa are kept constant and the variation of pressure altitude is studied for example when the 800hpa pressure altitude is shifted from 2060 to 2020 meter the low pressure generates above 2020meter altitude.Fig. 4. (a) Original image (b) BJUT watermark Image (c) Watermarked image (d) Recovered watermark Image

3.1. 800HPA PRESSURE VARIATION

Firstly, 800hpa pressure altitude variation is studied with respect to time in days. it is noticed that the 800hpa fluctuates between 1900 to 2070 meters altitude. In the first quarter, two oscillations are observed whose period of oscillation is 30 and 35 days. In the second quarter, one oscillation of 30 days and next oscillation is continued to the third quarter and the period of oscillation is 90 days finally in the last quarter two more oscillation is found in the interval of 40 and 30 days as shown the figure 1. At this pressure altitude, seven times the pressure has oscillated and so the frequency of this oscillation is seven.

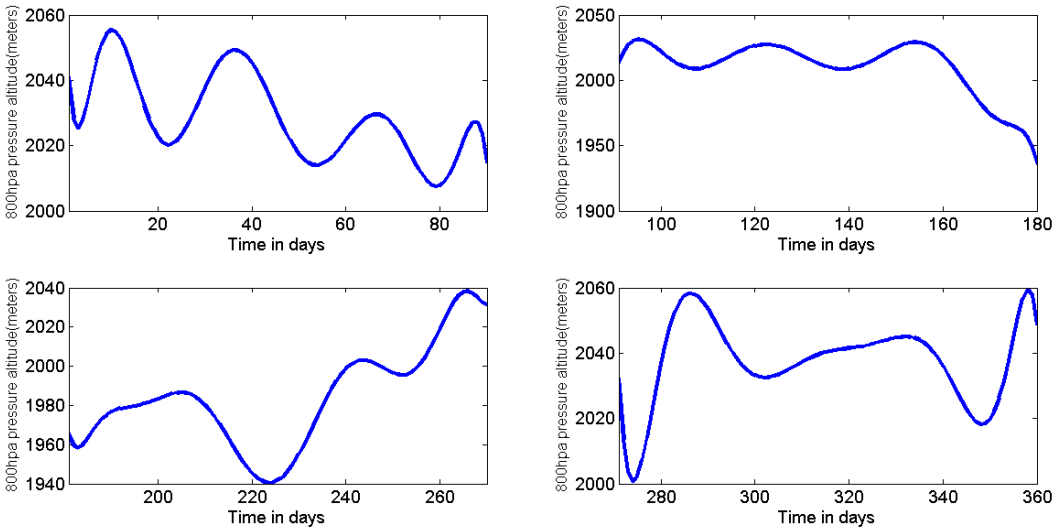

Figure.1 Pressure Altitude variation vs time for 800hpa

3.2. 600HPA PRESSURE VARIATION

The 600hpa pressure altitude varies In the range of 4340 to 4470 meters above the surface of the earth over the Hyderabad region. 600hpa pressure altitude is studied with respect to time and the graphs are plotted in four different windows in the first quarter of the year it is observed that the 600hpa pressure altitude varies three times with time period of 28, 30, and 30 days respectively as shown in the figure 2. Again 30 days of two oscillation are found in the second quarter. In the second quarter, one oscillation is carry forward to third and the period of this oscillation is 95 days. Eventually, in the last quarter, two oscillations are found with a time period of 45 and 26 days respectively.

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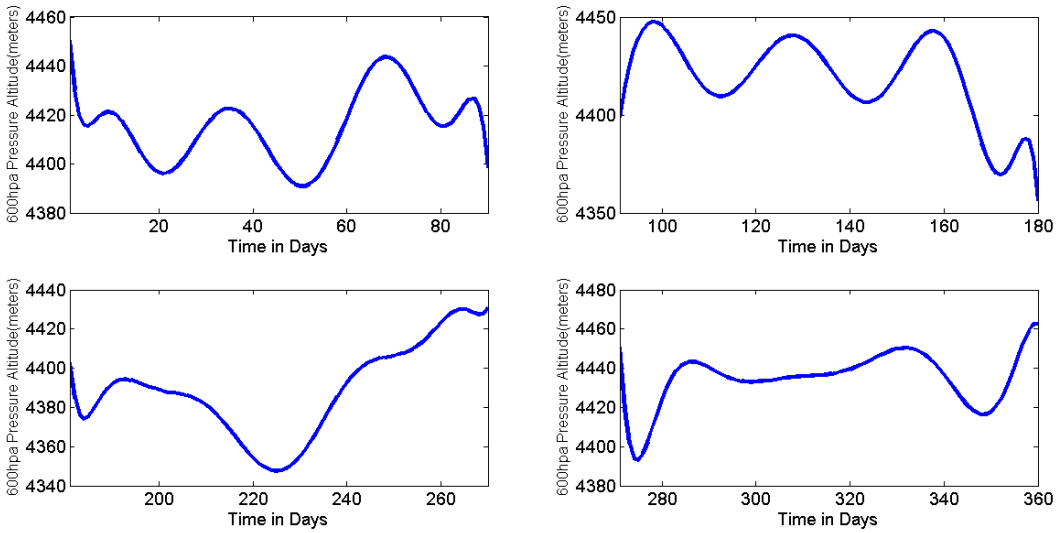

Figure.2 Pressure Altitude variation vs time for 600hpa

3.3. 400hpa pressure variation

400hpa pressure fluctuates in between the altitude range of 7500 to 7700 meters. The 400hpa pressure altitude with respect to time of the year 2018 is shown in figure 3. From figure 3 it is found that in the first quarter of the year only two oscillations are found with a time period of 32 and 35 days. Similarly in the second quarter of the year, two oscillations are noticed with the time period of 50 and 35 days respectively. Whereas in the third quarter only one oscillation of 55 days of a time period exists and the next oscillation is continued in the fourth quarter and three oscillation are observed in the fourth quarter with 35, 25 and 28 days period of oscillation. The frequency of the oscillation is found to be eight per annum.

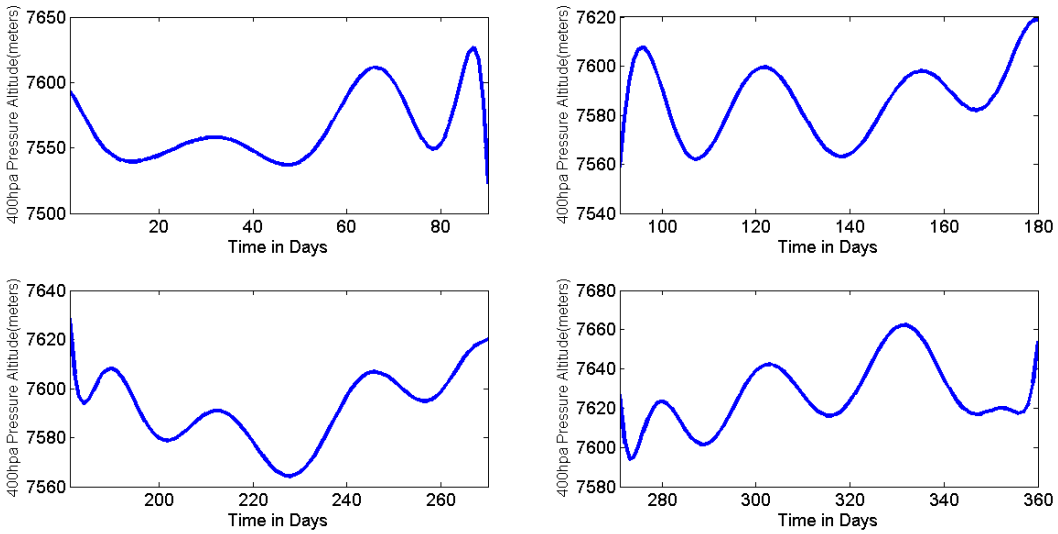

Figure.3 Pressure Altitude variation vs time for 400hpa

3.4. 200HPA PRESSURE VARIATION

The 200hpa is the upper limit where the clouds have existed above this pressure range there is very little chance of clouds formation. The altitude of 200hpa fluctuates in the range of 12200 to 12600 meters. The pressure variation of 200hpa with respect time is as shown in figure 4. in the first quarter of the year two oscillations are noticed with time

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period of 26 and 42days and the remaining days are considered in the second quarter of the year . in the second quarter two oscillation of 28 and 50 days of time period is found. In the third quarter of the year, only one oscillation of 30 days along with another 90 days of oscillation in the fourth quarter exists with one more of 30 days. The frequency of 200hpa pressure is found to be seven per annum.

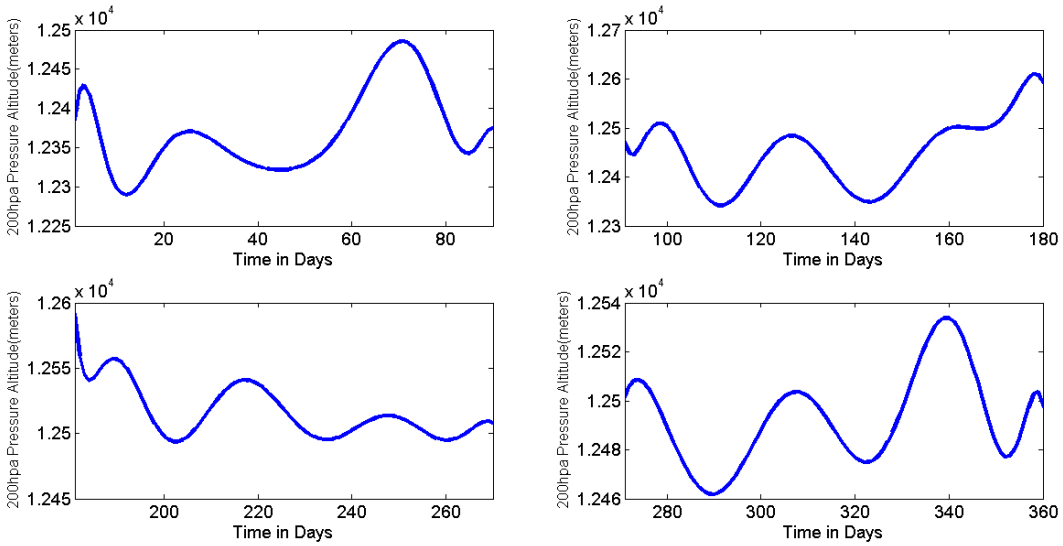

Figure.4 Pressure Altitude variation vs time for 200hpa

3.5 PRECIPITATION VARIATION

Precipitation is another parameter that supports this study of MJO using pressure variations. Hence precipitation values are evaluated from radiosonde data for the year 2018. The entire year is divided into four quarters and The precipitation with respect to time in days is plotted, as shown in figure 5. in the first quarter, the precipitation varies in 30 and 43 days of interval. Similarly in the second quarter, the precipitation of higher magnitude observed in the interval of 25 and 30days respectively. again In the third quarter, two oscillations of an equal time period of 35 days exist and from second to third quarter the two successive precipitation of higher magnitude in the interval of 90days. Finally, in the last quarter, the precipitation occurs in the interval of 30 and 43 days with less magnitude compare to other precipitation. The frequency of precipitation is seven per annum.

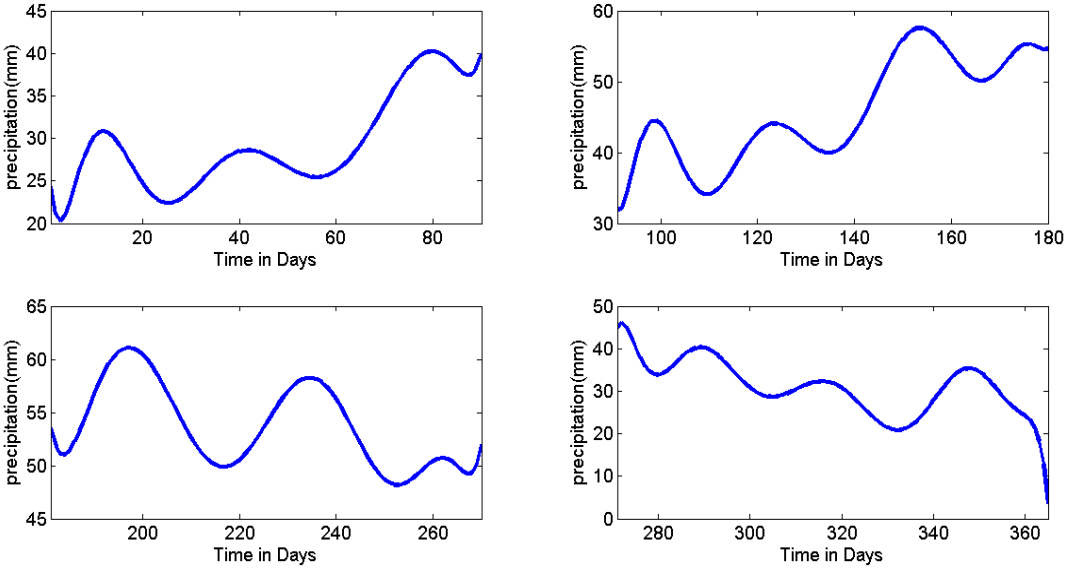

Figure.5 Precipitation vs time

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IV. CONCLUSION

The pressure variation and precipitation are in good agreement with each other. These two parameters reveal that rainfall occurring over the Hyderabad region is seven to eight times in the year i.e is the frequency of rainfall is approximately seven per annum and it is matched with the frequency[7] of MJO (7-8 per annum). This is clear evidence of the existence of MJO over Hyderabad station. The range of fluctuation, the period of oscillations and frequency of the oscillation is as follows.

PRESSURE	**FLUCTUATING RANGE (METERS)**	**TIME PERIOD OF OSCILLATION**								**TOTAL/ FREQUENCY**
		I	II	III	IV	V	VI	VII	VIII	8
800hpa	1900 - 2070	30	35	30	90	40	30	-	-	5
600hpa	4340 - 4470	28	30	30	30	30	95	45	26	8
400hpa	7500 - 7700	32	35	50	35	35	25	28	-	7
200hpa	12200 - 12600	26	42	28	50	30	90	30	-	7
PRECIPITATION	05 - 62	30	43	25	30	35	35	90	-	7

V. ACKNOWLEDGMENT

The authors express their sincere thanks to the Integrated Global Radiosonde Archive, NOAA for providing atmospheric Radiosonde data. Two of the authors Humair Hussain and H.Aleem Basha express their gratitude to the Vice-Chancellor, Maulana Azad National Urdu University, and Dr. Mazher Saleem principal of Sri Chaitanya college for their active support and encouragement.

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