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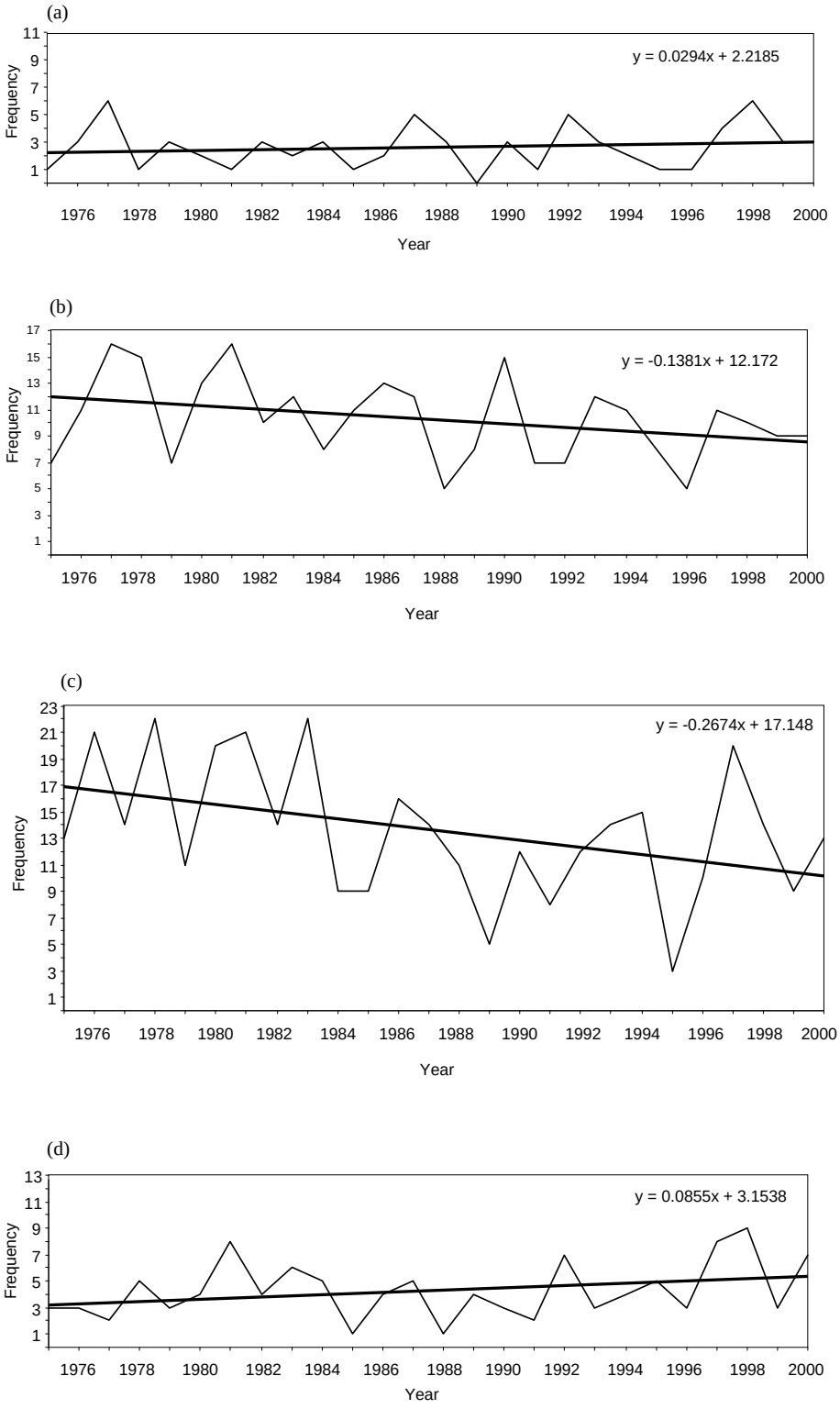
DIURNAL VARIATION OF THUNDERSTORM ACTIVITIES OVER KOLKATA DURING PRE-MONSOON SEASON

1. Thunderstorm activities during pre-monsoon (March to May) season are most hazardous in Gangetic West Bengal. This activities are lingered sometimes upto middle of June before set in of the south-west monsoon season. In pre-monsoon season, convective cumuli clouds are formed either in a large single cell or multiple cells due to instability condition in the atmosphere during persistent land heating in hot summer months. This heating sometimes accompanied with sufficient supply of moisture from the Bay of Bengal may cause a deep convection to form super-cell thunderstorm.

Desai (1950) has discussed some important facts regarding occurrences of thunderstorms over Bengal during summer months. Basu and Mondal (2002) in their earlier work have examined the forecasting aspect for propagation speed of thunderstorm cells over Kolkata during pre-monsoon season. They have also analysed the occurrences of multiple squalls within a few hours interval with the change of vertical wind shear between different levels through hodograph. Koteswaram and Srinivasan (1958) have studied the occurrence of thunderstorms in the pre-monsoon season over Gangetic West Bengal in relation to low level synoptic conditions as well as high level perturbation like passing of Jet-stream or trough of Jet-stream. Mathur and Kulshrestha (1966) have classified various types of radar-weather echoes in different seasons with an emphasis on convective type of echoes for development of thunderstorm in summer season.

In this paper, an attempt has been made to study the diurnal variation of thunderstorm activity with their statistical parameters like coefficient of variation, skewness, kurtosis and trends in different specified periods of time, such as morning, evening, night etc. during pre-monsoon season over Kolkata.

2. Upper air Radio-sonde data of Kolkata have been collected from Met. Office, Kolkata and NDC, Pune for the study of pre-monsoon thunderstorm occurrences over Kolkata. Frequency distribution of thunderstorm occurrences over Kolkata (Dum Dum Airport) during March to May for 26 years (1975-2000) have been studied and analysed for diurnal variations during morning (0600-1200 hrs IST), afternoon (1200-1800 hrs IST), evening/ night (1800-2400 hrs IST) and late night/early morning of next day (0000-0600 hrs IST). Statistical analysis of moments like skewness and kurtosis



Figs. 1(a-d). Diurnal trend of thunderstorm variation during (a) 0600-1200 hours (IST) in pre-monsoon season at Kolkata, (b) 1200-1800 hours (IST) in pre-monsoon season at Kolkata, (c) 1800-2400 hours (IST) in pre-monsoon season at Kolkata and (d) 0000-0600 hours (IST) in pre-monsoon season at Kolkata

TABLE 1

Statistical parameters of diurnal frequency distribution of thunderstorm occurrences during pre-monsoon season over Kolkata

S. No.	Period hrs (IST)	Mean	Standard deviation	Coefficient of variation (%)	Skewness	Kurtosis
1	0600- 1200	2.615	1.602	61	0.627	2.894
2	1200- 1800	10.308	3.184	31	0.195	2.253
3	1800- 2400	13.538	5.116	38	0.088	2.579
4	0000- 0600	4.308	2.131	49	0.611	2.778

alongwith trends of such frequency distributions have been calculated using 'STATISTICA' software. The co-efficient of variations during diurnal frequency distribution have also been calculated.

The co-efficients of Skewness (g_1) and kurtosis (g_2) for frequency distribution of thunderstorm occurrences are given by

$$g_1 = \frac{m_3}{s^3} \text{ and } g_2 = \frac{m_4}{s^4}$$

where, m_3 and m_4 are 3rd and 4th moments respectively of frequency distribution with standard deviation '*S*'.

$$m_3 = \frac{1}{N}\sum_{i=1}^{N}(X_i - M)^3 \text{ and}$$

$$m_4 = \frac{1}{N}\sum_{i=1}^{N}(X_i - M)^4$$

where, X and M are the variable and the mean respectively of the frequency distribution.

The co-efficient of variation (V) of diurnal frequency distribution of thunderstorm occurrences is given by

$$V = (S / M) \times 100$$

The trends (Y) of diurnal frequency distributions for different time periods of thunderstorm occurrences during pre-monsoon season are fitted by a regression line , as suggested by Basu and Basu (2001) and is given by

$$Y = a + b X_i$$

where, X_i number of years; 'a' and 'b' are constants to be evaluated by 'least square method'.

3. Variation of thunderstorm occurrences in pre-monsoon season over Kolkata (Dum Dum Airport) during morning [0600-1200 hrs (IST)], afternoon [1200-1800 hrs (IST)], evening/ night [1800-2400 hrs (IST)] and late night/ early morning of next day [0000-0600 hrs (IST)] with their trend lines are given in Figs. 1(a-d), showing increase or decrease of trend in different periods. The diurnal variation of thunderstorm occurrences and its trends in pre-monsoon season, show increasing trends during 0600-1200 hrs (IST) [Fig. 1(a)] and 0000-0600 hrs (IST) [Fig. 1(d)], while decreasing trends are noticed during 1200-1800 hrs (IST) [Fig. 1(b)] and 1800-2400 hrs. (IST) [Fig. 1(c)].

The trends (Y) of diurnal variation of thunderstorm occurrences during different time periods are fitted by regression equations and are given below :

$Y = 0.0294 X + 2.2185$ for period 0600-1200 hrs (IST)

$Y = -0.1381 X + 12.172$ for period 1200-1800 hrs (IST)

Y = -0.2674 X + 17.148 for period 1800-2400 hrs (IST)

Y = 0.0855 X + 3.1538 for period 0000-0600 hrs (IST)

The asymmetry and peakedness of frequency distribution by statistical moments of skewness and kurtosis for diurnal variations of thunderstorm occurrences over Kolkata (Dum Dum Airport) have been shown in Table 1. The highest positive value of co-efficient of skewness is 0.627 during morning, while the least value of the same is 0.088 during evening/night in pre-monsoon season over Kolkata which indicates the frequency distribution of thunderstorm occurrences nearly symmetrical. The highest and lowest means of thunderstorm occurrences in pre-monsoon season over Kolkata are 13.538 and 2.615 during evening/night and morning respectively. The coefficient of variations of thunderstorm occurrences in pre-monsoon season over Kolkata for highest and lowest values are 61% and 31% during morning and afternoon respectively. The kurtosis of frequency distribution of thunderstorm occurrences over Kolkata (Dum Dum Airport) lies between 2.894 and 2.253 which indicates that the frequency distributions are nearly meso-kurtic for all periods of diurnal variations (Table 1).

4. By the above study of diurnal variation and statistical moments of thunderstorm occurrences during pre-monsoon season over Kolkata, following salient features are revealed.

(*i*) Trends of diurnal variation of thunderstorm occurrences in pre-monsoon season are increasing in nature during morning and late night/ early morning, while those are decreasing nature during afternoon and evening/night.

(*ii*) Statistical moments like kurtosis and skewness for all diurnal variations of frequency distribution of thunderstorm occurrences are nearly meso-kurtic and positive skewness respectively. The coefficient of variation is large 61 % during morning and less 31 % during afternoon, indicates higher relative variability in frequency distribution of thunderstorm occurrences during morning than during afternoon.

(*iii*) The mean frequencies of occurrences of thunderstorm are of larger values during evening/ night (13.538) and afternoon (10.308), while those are smaller values during morning (2.615) and late night/early morning (4.308). The larger frequencies of occurrences of thunderstorm during above periods are due to persistent land heating by day-time insolation alongwith supply of moisture causing instability to form thunderstorm cells towards afternoon and evening.

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