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A study of pre-monsoon thunderstorms in central parts of India

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ABSTRACT. The distribution of average rainfall in a thunderstorm field over central parts of India during the pre-monsoon period (March to May) has been analysed from two different angles. The average distribution of thunderstorms, hailstorms and associated rainfall inside the moist sector in a potential thunderstorm field have also been presented in the paper. The data of all the observatories, including the hydromet observatories, situated in Madhya Pradesh and Vidarbha for the period 1951-57 have been utilised for this study.

1. Introduction

A study of pre-monsoon thunderstorms in the Peninsula has been made by Venkiteshwaran (1932). Some of the thunderstorm activities in central parts of India, during the pre-monsoon period, are noted for their destructive violence like the Nor'westers of Bengal. In fact wind speed as high as 120 km/hr in squalls has been recorded at several stations in this area during the spells of violent thunderstorm activity. The main object in the present paper is to study in detail the typical characteristics of potential thunderstorm fields that often develop over central parts of India under the influence of a western disturbance or its secondaries.

2. The preferred regions where thunderstorms occur earliest in the afternoon

The general contour of the area which has been selected for the present study is shown in Fig. 1. The network of reporting stations in this area is also indicated in the figure.

For locating the region where thunderstorms occur earliest in the afternoon, the time of onset of the thunderstorm activity at the various stations is plotted and the isochrones at an interval of one hour are drawn. From the nature of the isochrones, the region of earliest occurrence of thunderstorms can be spotted out. A typical case is depicted in Fig. 2. On some occasions, two or three such regions could be located.

The preferred regions of earliest occurrence of thunderstorms in the afternoon are invariably found to be within the coverage of the 450 m contour line lying between 21° and 25° N (*cf.* Fig. 1). The frequency of the earliest occurrence of thunderstorms within an area of about 50 miles around Pachmarhi is, however, the greatest. In fact, 58 per cent of the total of such thunderstorms have been located in this small hilly patch which happens to be the highest elevated area in the region. This particular area appears to be very effective in generating thunderstorm sequences of destructive character. Nagpur airport experienced severe squalls with wind speed exceeding 120 km/hr on three different occasions during the passage of thunderstorms, the origin of which appeared to be situated in this area.

Within the coverage of 450 m contour line lying to the northwest of Nagpur, 85 per cent of the earliest occurred thunderstorms have been found. This probably explains the finding, during the course of the present study, that the frequency of the thunderstorms affecting Nagpur from a N/NW direction during the pre-monsoon period is the greatest. Out of the remaining, 10 per cent of the earliest occurred thunderstorms have been located over the hilly areas in the neighbourhood of Pendra and the remaining 5 per cent over plain land

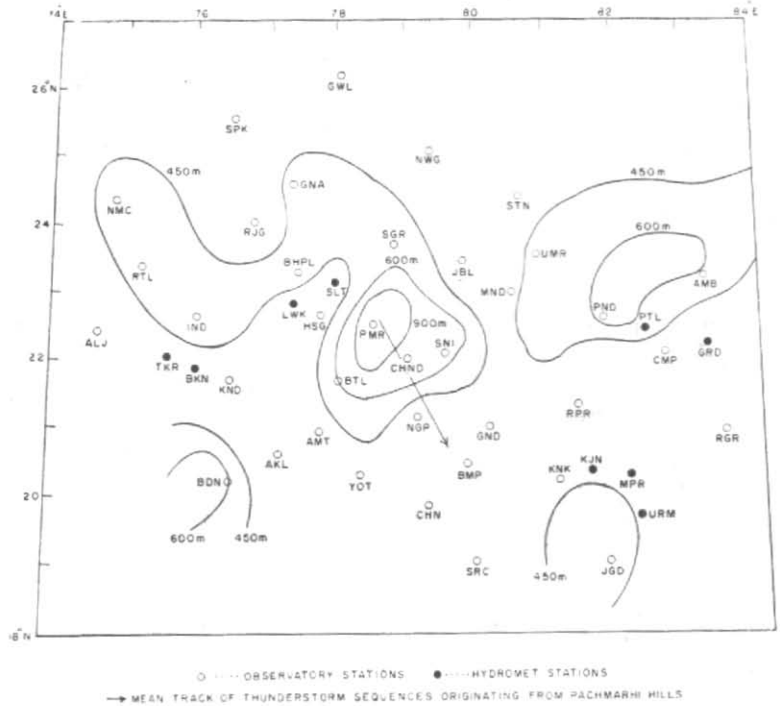

Fig. 1

under typical synoptic situations envisaged by Roy (1949).

3. Rainfall distribution

The distribution of average rainfall in a thunderstorm field has been analysed from two different angles. One is the octant-wise distribution round the centre of the region of earliest occurrence of thunderstorm activity and within the distance-ranges 0—50, 51—100, 101—150, 151—200, 201—250, 251—300, 301—350 and 351—400 miles from it. The other is the distribution inside the moist sector within the same distance ranges from its boundary.

(*A*) *Distribution round the centre of the region of earliest occurrence of thunderstorm activity*—For the purpose of calculating the average rainfall within the area of a specified distance range enclosed by a particular octant, the number of thunderstorms (including the dry thunderstorms) that occurred in that area on different occasions and the total rainfall associated with these are noted and the quotient of the latter to the former is taken as the average rainfall per thunderstorm for that particular area. In this way the average rainfall for each of such different areas is worked out and plotted on a polar diagram at the appropriate centre of the area concerned. The polar diagram with the isohyets is presented in Fig. 3. The exact number of thunderstorms and the highest rainfall that occurred in each of these areas are indicated in Table 1. The isohyets, which depict the average distribution of rainfall, should be viewed with due weightage to the number of thunderstorms which occurred in different areas.

It is obvious from Fig. 3 that the wettest area is very narrow patch situated about 40 miles SSE of the centre of the region of earliest occurrence of thunderstorm activity. The northern octants are mostly dry,

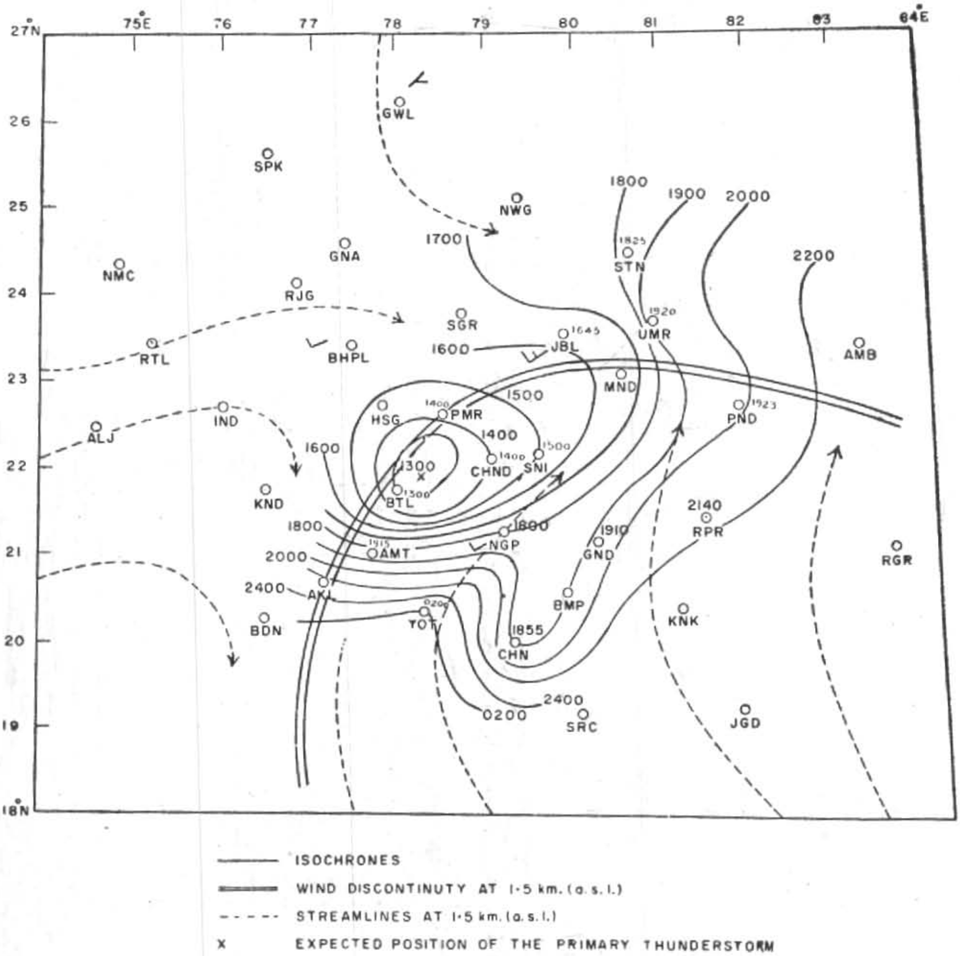

Fig. 2. Pattern of thunderstorm isochrones on 10 March 1957

whereas, the southern octants are comparatively wet upto a considerable distance from the centre. The penetration of the 10-mm isohyet upto a distance of nearly 250 to 350 miles in the southern quadrants, particularly in the southwest quadrant is significant. The distribution of rainfall clearly indicates that the air mass to the north is relatively drier than that which prevails to the south. Roy (*loc. cit.*) also envisaged a similar structure for the air masses participating in a thunderstorm field in Central India during the pre-monsoon period.

(*B*) *Rainfall distribution within the moist sector*—For the purpose of assessing the average distribution of rainfall within the moist sector, the nearest distance of each

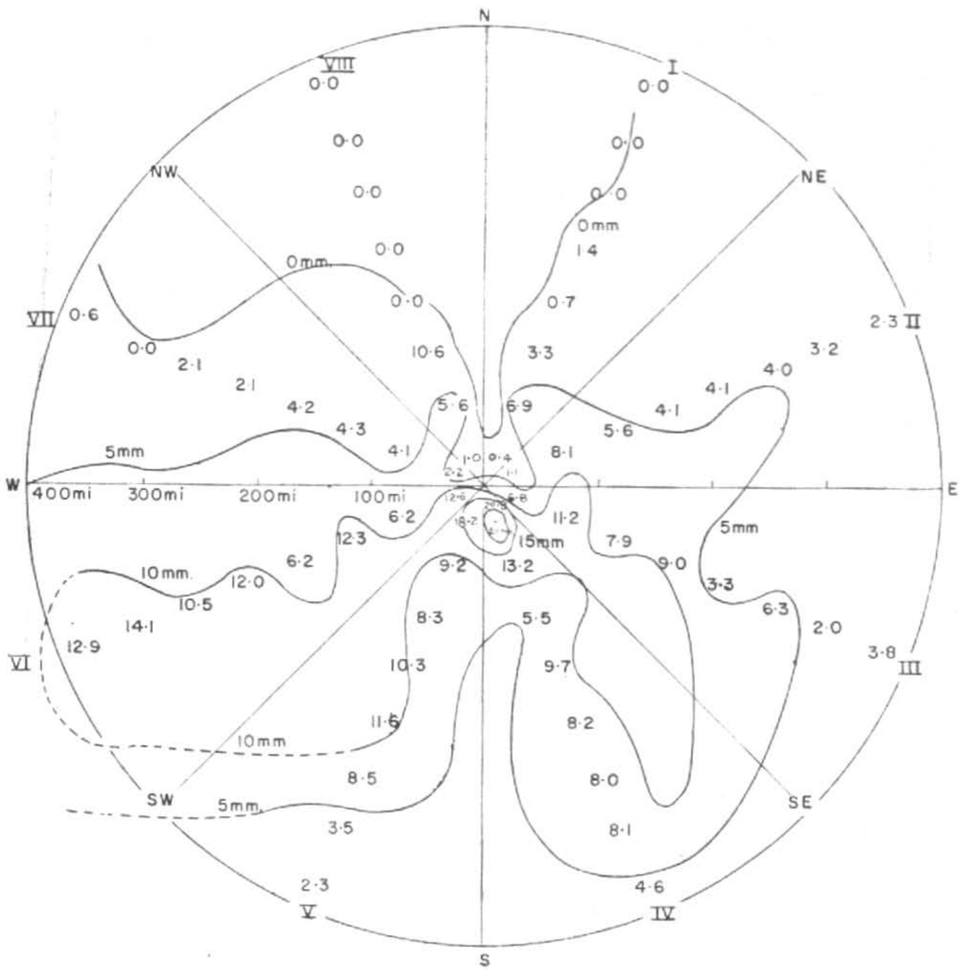

Fig. 3. Rainfall distribution round a primary thunderstorm

thunderstorm from the wind discontinuity at 1·5 km a.s.l. separating the moist and the dry air masses and, the rainfall associated with it are noted. The thunderstorms, are then, grouped as per the distance ranges mentioned earlier and the average rainfall per thunderstorm within a specified distance range is calculated in the usual way. The distribution of average rainfall within the moist sector is shown in Fig 4(a). The value of the average rainfall (in mm) for a particular distance range is plotted at the mid-point of that range. The figure at the top of each representative point of the diagram represents the highest rainfall (in mm) recorded in the range concerned on an individual occasion. The variation in the average rainfall inside the moist sector within a distance of 200 miles is very little, the range being only about 4 mm. Thus

TABLE 1

Distance Ranges (miles)	Octant I	II	III	IV	V	VI	VII	VIII
0— 50	3 (3·8)	3 (2·0)	4 (11·4)	8 (50·5)	4 (22·1)	6 (39·3)	2 (8·0)	2 (6·6)
51—100	4 (13·2)	16 (18·4)	14 (39·4)	16 (55·2)	7 (20·1)	8 (23·0)	3 (7·1)	5 (9·3)
101—150	6 (8·4)	8 (14·0)	10 (22·2)	14 (11·1)	12 (19·5)	6 (41·0)	3 (10·0)	2 (3·6)
151—200	2 (1·0)	6 (16·0)	15 (47·7)	15 (40·8)	9 (36·3)	6 (18·6)	4 (10·0)	0 (0·0)
201—250	2 (4·6)	4 (8·0)	9 (7·6)	8 (18·3)	8 (55·2)	9 (39·9)	2 (22·2)	0 (0·0)
251—300	0 (0·0)	3 (9·1)	10 (17·5)	2 (1·0)	4 (14·4)	5 (57·0)	2 (3·3)	0 (0·0)
301—350	0 (0·0)	3 (4·1)	4 (5·7)	3 (8·1)	2 (12·1)	4 (26·9)	0 (0·0)	0 (0·0)
351—400	0 (0·0)	3 (8·6)	2 (3·8)	5 (12·2)	2 (6·2)	5 (21·0)	0 (0·0)	0 (0·0)

NOTE—Figures without brackets represent number of thunderstorms that occurred in the area concerned and those with brackets indicate the highest rainfall (in mm) recorded in that area on an individual occasion

the thunderstorms remain active even at great depths within the moist sector. Probably the fresh moist current provides the energy for rejuvenation. Roy (*loc. cit.*) observed that the maximum activity of rain and thunderstorm occurs at a distance of 50 to 100 miles within the moist sector. Such a concentration of activity is, however, noticed on a few individual occasions during the present study. The average distribution of rainfall within the dry sector has not been attempted in view of the meagre number of thunderstorms that occurred in that sector.

4. Distribution of thunderstorms and hailstorms inside the moist sector

The frequency of occurrence of thunderstorms and hailstorms at various distance ranges within the moist sector are shown in Fig. 4(b). The frequency of occurrence of thunderstorms gradually falls off with distance but, that in respect of hailstorms is, however, greatest within 25 to 50 miles inside the moist sector.

During the present study the existence of thunderstorm sequences which originate around the Pachmarhi hills and move in a

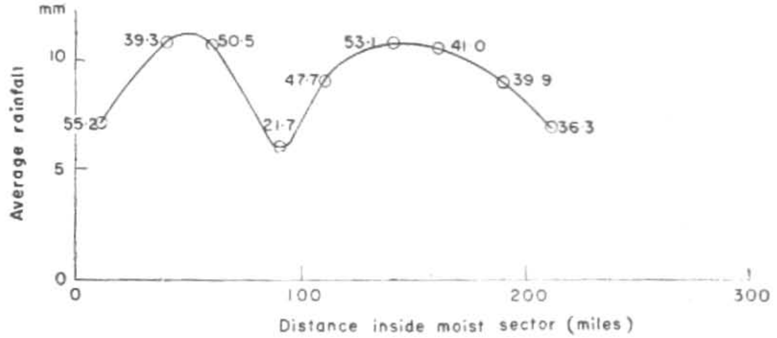

Fig. 4(a). Distribution of rainfall inside moist sector

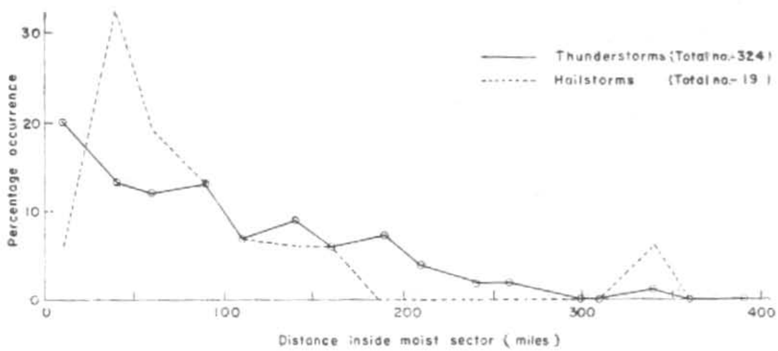

Fig. 4(b). Distribution of thunderstorms and hailstorms inside moist sector

NW-SE direction has been felt. The collected data in respect of the manner of propagation of these thunderstorm sequences and the average rate of their movement in relation to the prevalent wind field with the help of the existing network of reporting observatories in the region will be discussed in a subsequent paper after critically examining these data in the light of the radar observations taken from Meteorological Office, Nagpur.

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