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Northeasters of Tripura State

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ABSTRACT. A study of thundersqualls over Agartala during pre-monsoon months for a period of 12 years (1962-73) has revealed that frequency of squalls from N-E quadrant is significantly greater than those from N-W quadrant in each month. As such, the term 'Nor'wester' assigned to the thundersqualls of Bengal and adjoining eastern regions may not perhaps be an appropriate qualifying term for the thundersqualls which affect Tripura State. The average speed associated with squalls from N-W quadrant was, however, found to be greater than those from N-E but the average rainfall associated with the latter was significantly greater than that associated with the former. Thunderstorms from N-E quadrant are the principal contributors to the pre-monsoon rain in Tripura.

1. Introduction

During the pre-monsoon period (March-May), significant scattered radar echoes frequently form in the morning hours in the N-E quadrant at Agartala. At times, the echoes organise themselves into NW-SE oriented lines in this sector and progressively move SW/S towards the station and give rise to thundersqualls from NE/N associated with moderate to heavy rain. Two such well-marked sequences affected Agartala and adjoining areas within a brief interval of only 7 hours in the moring of 8 May 1973 and resulted in very heavy rains and floods.

Greater frequency of movement of radar echoes towards the station from N-E quadrant as compared to those from other quadrants during pre-monsoon period led to the inquisition whether frequency of thundersqualls from N-E quadrant at Agartala is also logically greater than those from other directions in this period. The present study is the result of that quest.

2. Data

For supplying wind data for aviational purposes, Agartala (23°53'N, 91°15'E, 17·1 m a.s.l.) has been provided with a Distant Indicating wind equipment. As and when squalls affect the station wind observations at an interval of one minute are recorded. In fact, wind observations are taken every minute whenever the speed exceeds 20 kt and are continued till the winds subside and fall below 20 kt. Squall data, as recorded in the manner indicated above, are available for a period of 12 years (1962-73) and the same has been utilised in the present study. Tripura being a small State of area of only about 10,000 sq. km, results of analysis of squalls at Agartala may perhaps be representative for the State as a whole. Squall data of Agartala, however, suffers from one drawback, that it is not based on autographic record like anemogram but on instrumental observations. As such, observation on peak wind speed etc during squalls will have some personal bias.

3. Results and Discussions

Results of analysis of 160 squalls which were experienced at Agartala during 12 years period from 1962 to 1973 in the pre-monsoon months are presented in Table 1.

(a) *Squalls from N-E quadrant*

The results point out that in each of the pre-monsoon months, the frequency of squalls from N-E quadrant (360°-090°) is the greatest and is significantly so in April and May. The squalls from N-E quadrant will hereafter be referred to as 'Nor'easters'. Nor'westers are also quite frequent at Agartala but not as frequent as the Nor'easters. It is also noteworthy from Table 1 that the average rainfall associated with a Nor'easter in each of the pre-monsoon months is significantly greater than that associated with a Nor'wester. Over Tripura State, Nor'easters seem to be the greatest contributor of pre-monsoon rain both from the point of view of their incidence in larger numbers and

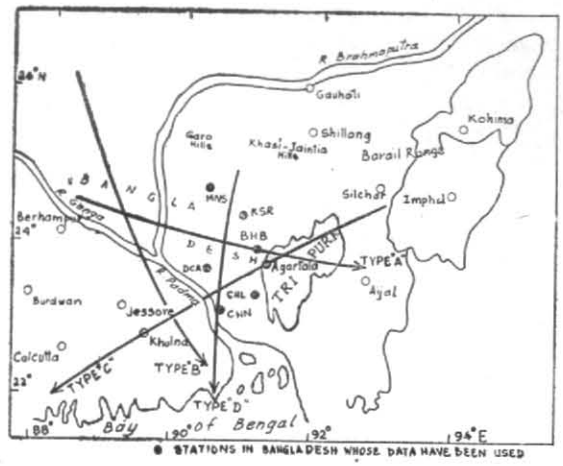

Fig. 1. Map of Bangladesh and adjoining States. Thick arrows represent the typical tracks of nor'westers stations in Bangladesh bordering Tripura State (Table 2) are shown by shaded circles.

TABLE 1

Monthwise distribution and characteristics of thundersqualls from different quadrants during pre-monsoon period at Agartala

(Based on 12 years data 1962-1973)

Thunder-squalls	March				April				May				Total			
	NE	NW	SE	SW	NE	NW	SE	SW	NE	NW	SE	SW	NE	NW	SE	SW
No. of thunder-squalls	8	7	2	2	29	15	8	16	39	18	5	11	76	40	15	29
Average speed (kt)	31·8	38·5	—	—	34·7	37·5	31·0	37·7	31·7	41·7	35·6	36·5				
Squalls with speed 50 kt or more	1	2	0	0	5	0	0	1	2	5	0	1				
Highest speed (kt) recorded	58	55	—	—	70	45	35	55	70	80	45	55				
Average rainfall (mm)	20·4	11·1	—	—	39·2	16·8	6·4	1·2	46·8	34·3	26·9	19·1				
Highest rainfall (mm)	49·2	52·2	—	—	84·0	46·5	18·6	6·0	136·7	51·5	36·5	59·1				

— Values not available

Total number of squalls from all quadrants = 160

also in association with greater amount of rainfall. As such, instead of Nor'wester, it will be more appropriate to qualify the pre-monsoon thundersqualls of Tripura by the term Nor'easters or Northers. The average wind speed associated with a Nor'wester is, however, somewhat greater than that associated with a Nor'easter (*vide* Table 1).

(b) *Results of Thunderstorm Project-1941*

Occurrence of Nor'easters or Northers (thundersqualls affecting station from N-E quadrant) at stations bordering Tripura State in the eastern regions of former Bengal (now Bangladesh) was noticed quite early. During April and May 1941, a project was launched for special investigation on the origin, nature and other characteristic features of Nor'westers in Bengal by a team of meteorologists from India Meteorological Department. A fairly close network of observation stations within about 80 km of each other was set up in whole of former Bengal for this purpose. The results of this investigation are incorporated in *Tech. Note* No. 10 of India Met. Dep. (1944).

On the basis of these results, thunderstorms of Bengal were classified into four types (A,B,C and

TABLE 2

Frequency of thunderstorms of various types experienced at stations in Bangladesh situated near border of Tripura State during April and May 1941 (reproduced from Tech. Note No. 10 I. Met. Dep.)

Station (shown in Fig. 1 as)	No. of thunderstorms of different types			Total
	A and B	C and D	Other types	
Brahmanbaria (BHB)	12	10	3	25
Kishorganj (KSR)	15	11	2	28
Mymensingh (MNS)	9	6	1	16
Dacca (DCA)	14	12	3	29
Comilla (CML)	11	11	3	25
Chandpur (CHN)	10	12	2	24

Note : Types A and B are expected to approach from 270° to 360° (W-N) and types C and D are expected to approach from 360° to 090° (N-E)

D). The typical track of each of the above four types from their source regions are indicated by arrows in Fig. 1. Type A represents the typical Nor'westers and accounts for 45 per cent of thunderstorms. The other three types, namely B, C and D originate from the foot of the hills flanking northern and eastern borders of Bangladesh and Assam and they have been differentiated according to the regions of their origin. Those starting from submontane districts of north Bengal have been classified as type B, those from the eastern hills as type C and those from the foot of Khasi hills as type D.

(c) *Preponderance of squalls from N-E quardrant over Tripura and adjoining areas of Bangladesh*

From the situation of the State of Tripura in relation to the tracks of different types of thunderstorms (Fig. 1), it is expected that types C and D will give rise to squalls from N-E quadrant over Tripura and adjoining regions of Bangladesh and types A and B from N-W quadrant. Now, the State of Tripura being very close to the source region for the type C thunderstorms, it is expected that these thunderstorms would remain quite active while moving through Tripura at least. Moving further SW/S-wards beyond Tripura, they may, of course, weaken due to longer travel and may on many occasions die out. This may perhaps be one of the principal reasons for preponderance of Nor'easters/Northers in Tripura over thundersqualls from other directions as is evidenced in the present study of thundersqualls at Agartala. Preponderance of squalls from N-E quadrant can also be expected over stations in Bangladesh bordering Tripura as a logical consequence. The project data of 1941 (*loc. cit.*) indicating frequency of occurrence of different types of thunderstorms at stations in Bangladesh bordering State of Tripura is relevant in this context. The data of these border stations are reproduced in Table 2 and their positions are also marked in Fig. 1 with shaded circles. The data indicate that thunderstorm of types C and D occur over these Bangladesh stations in slightly lesser number than those of types A and B. That is, frequency of thundersqualls from N-E quadrant at these stations can be expected to be close to and comparable with the frequency of squalls from N-W quadrant on the basis of the above data. As such, there is close similarity in the results obtained in the present study in regard to direction of approach of squalls at Agartala and those obtained from project data of 1941 (*loc. cit.*) for stations in Bangladesh situated close to Agartala. It should, however, be borne in mind that the project data is based on observations for one pre-monsoon period only (April-May 1941) and therefore the results obtained thereof cannot be expected to be as representative as the results obtained in the present study. Perhaps data for more number of years may reveal predominance of Nor'easters over these stations in Bangladesh during pre-monsoon season as observed in case of squalls at Agartala.

(d) *C-type thunderstorms*

Thunderstorms of type C have special interest to the meteorologist as they generally move against the prevailing W/NW flow in the mid-troposphere. In the current literature, De (1958) referred to this type of thunderstorm in a case study of northeasterly squall at Dum Dum (Calcutta). However, on the basis of radar observations, he observed that initially the thunderstorm cells formed 40 to 50 miles northeast of Calcutta in this case and not near the eastern hills, stated to be the source region for this type of thunderstorms in the results of the 1941 project. In this paper, De has also discussed at length the possible reasons on account of which the storm moved southwestwards against the prevalent mid-tropospheric W/WNW flow. Considering the elevated topography to the north and east of Tripura State, and the fact that NE/N-ers are more frequent in the early morning hours, katabatic wind towards W or S may also help the drift of the thunderstorm cells in that direction giving NE or N'ly squalls over Tripura State.

Approach of thunderstorms and squalls from N/NE at Agartala was also noticed by other investigators. In a comparatively recent paper Kundu and De (1969) referred to these thundersqualls as 'Northers'.

TABLE 3

Diurnal variation of thundersqualls at Agartala from the four quadrants

(Based on data from 1962 to 1973)

Period (IST)	Number of squalls from direction (Quadrant)			
	360°-090° (NE)	091°-180° (SE)	181°-270° (SW)	271°-359° (NW)
00 – 02	6	0	1	0
02 – 04	6	0	1	1
04 – 06	8	0	1	0
06 – 08	9	0	1	1
08 – 10	12	0	0	1
10 – 12	4	0	2	2
12 – 14	3	0	2	3
14 – 16	5	3	5	7
16 – 18	6	3	4	8
18 – 20	6	6	9	10
20 – 22	5	3	3	6
22 – 24	6	0	0	1
Total	76	15	29	40

4. Conclusions

The following conclusions can be drawn from the present study :

(1) Occurrence of thundersqualls from N-E quadrant over Tripura during each of the pre-monsoon months is more frequent than those from N-W quadrant. Project data of 1941, for neighbouring stations in Bangladesh have also close resemblence in this regard.

(2) The average rainfall associated with a Nor' easters/Northers is significantly greater than that associated with a Nor'wester. The Nor'easters/ Northers are the greatest contributors of pre-monsoon rain in Tripura under favourable synoptic conditions.

(3) The squalls from N-W quadrant in Tripura have, however, on the average greater speed associated with them than those associated with Nor'easters.

(4) The Nor'easters have greater tendency to affect Tripura in the morning hours (*vide* Table 3).

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