

Premonsoon thunderstorms in Assam, Tripura and Manipur

A. K. CHAUDHURY

Meteorological Office, Agartala

ABSTRACT. The paper contains analyses illustrating the contribution of low level convergence towards the development of premonsoon thunderstorms in the States of Assam, Tripura and Manipur.

1. Introduction

Our eastern states—Assam, Tripura and Manipur are very frequently visited by thunderstorms during the premonsoon months. These thunderstorms on some occasions are violent and of devastating nature having in accompaniment, heavy showers, severe surface squalls and hail.

The study of synoptic charts of a number of days reveals that widespread premonsoon thunderstorm activity in the States of Assam, Tripura and Manipur is generally associated with the easterly movements of low pressure waves or secondary western disturbances along the foot hills of the Eastern Himalayas. Intense thunderstorm activity is also favoured by the appearance of "lows" in the central part of Bengal—stationary or with little easterly or northeasterly movements.

It is also a fairly common experience that the occurrence of premonsoon thunderstorms in this region is most favoured on those days when latent instability is present in the atmosphere. Operation of certain triggers is necessary to release this latent energy which, in its turn, helps the development of the cumulonimbii. Isolational heating in the lower layers of the atmosphere serves the trigger action though it is not always sufficient. Low level horizontal convergence of air, which through its vertical spreading action serves to steepen the lapse rate (Namias 1940), can also render the warm air mass more unstable and can thus favour the lifting. In addition to the location of "lows" on the surface charts and of the associated cyclonic circulations in the upper air, the locations

of the zones of divergence and convergence in the lower layers of the atmosphere can, therefore, provide another tool for forecasting the thunderstorms. Mull, Gangopadhyaya and George (1955) and Bose (1957) have found this useful in their studies on the nor'westers of Bengal. It is, therefore, felt worthwhile to study the patterns of the low level convergence and to see if these had any suggestion on the patterns of the distribution of the thunderstorms in this region, although it is realised that the flow pattern at the lower levels would be considerably influenced by topography. If we want to choose a level high enough not to be influenced by topography the number of observations will naturally fall down. At the same time, winds at very low levels will be seriously affected by orography. As a compromise, therefore, the level of 1.5 km a.s.l. has been chosen in the present study. It may be mentioned here that the average height of the high grounds in this region is also in the neighbourhood of 1.5 km.

2. Data examined

Patterns of convergence and divergence at 1.5 km level drawn for both 0730 and 1430 IST for each of the days from 18 to 25 March 1955 have been examined. It will be seen that on most of these days widespread thunderstorms had occurred in the region, a few being of severe nature. A number of hailstorms had also occurred during the period under review when the average size of the stones varied from that of a pea to that of a ping-pong ball (diameter 2" at Gauhati on 21 March). Pibal observations of the stations of northeast India, East Pakistan and also of

Akyab were utilised for mapping of fields of convergence and divergence. Reports on weather were collected from the registers of the observations concerned.

3. Procedure

Let x and y be the two cartesian co-ordinates in the east and in the north direction and u and v the two velocity components in the x and y directions respectively. Then the horizontal velocity divergence $\text{div } V$ is given by

$$\text{div } V = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}$$

The procedures adopted for computations are as follows—

- (i) resolution of wind vectors in the components of u and v ,
- (ii) mapping of the isolines of u and v separately,
- (iii) determining from above, the values of $\partial u/\partial x$ and $\partial v/\partial y$ separately at a number of fixed positions on the field,
- (iv) calculating $[(\partial u/\partial x) + (\partial v/\partial y)]$ on these positions in the units of 10^{-5} /sec, and
- (v) locating the areas of divergence and convergence.

In Figs. 1–4, the convergence pattern at 0730 and 1430 IST is shown in blocks (a) and (b) respectively. In blocks (c) are shown the weather that had occurred in the mornings of the days. Weather occurring during afternoon to evening on the days are shown in blocks (d).

4. Discussions and results

18 March 1955—At 0730 IST convergence was taking place over the region north of 24°N with a markedly deep core (inner zone of higher values) between 92°E and 95°E north of 24°N . At 1430 IST the entire region east of 90°E became a field of convergence with a core in northeast Assam. There were two phases of weather—

- (i) In the morning, Mohanbari, Sibsagar, Jorhat and Lumding were having rain; Silchar and Kohima were having thunderstorms. This weather zone corresponds to the zone of maximum values of convergence, *i.e.*, the core and its northeast vicinity.
- (ii) The second phase of weather—mostly thunderstorms occurred extensively within the convergent field as modified at 1430 IST.

19 March 1955—At 0730 IST convergence was taking place over the region east of 90°E with a core south of 25°N . At 1430 IST there was not much change in the extent of the field. There were two phases of weather—

- (i) In the morning there were thunderstorms at Silchar, Agartala, (Dacca and Chittagong in East Pakistan) and rain at Cherrapunji.
- (ii) Thunderstorms had occurred extensively in the afternoon/evening mostly in the inner field of convergence as modified at 1430 IST.

20 March 1955—There was not much change in the extent of the two fields. The important feature of the 0730 IST pattern was in the presence of two zones of higher values—one in the northeast Assam and the other in Cachar and Manipur. There were two phases of weather—

- (i) In the morning rain or thunderstorm were fairly widespread in the region east of 93°E north of 24°N .
- (ii) Rain and thunderstorms also occurred extensively during late afternoon and evening in the existent field of convergence.

21 March 1955—At 0730 IST there were two distinct zones where convergence was taking place—one in the northeast Assam and the other in East Pakistan and adjoining south Assam and Tripura State—the two

zones being separated by a shallow field of divergence. At 1430 IST convergence was taking place practically over entire area west of 94°E . The two phases of weather were—

- (i) In the morning—
 - (a) Tezpur reported thundery conditions, Sibsagar and Mohanbari reported rain, and
 - (b) Agartala and Gauhati reported thunderstorms and Cherrapunji reported rain.

Weather under (a) evidently corresponds to the convergent zone in northeast Assam and weather under (b) corresponds to the zone in East Pakistan and adjoining Assam and Tripura.

- (ii) Thunderstorms had occurred extensively in the field of convergence of 1430 IST during the evening.

22 March 1955—At 0730 IST there were two distinct zones where convergence was taking place—one in northeast Assam and the other in East Pakistan and adjoining south Assam and Tripura State. At 1430 IST convergence was taking place practically over entire area west of 94°E with a core over the Garo-Khasi hills and the northern neighbourhood. There were two phases of weather—

- (i) In the morning—
 - (a) Sibsagar and Lumding reported rain, Jorhat and Mohanbari reported thunderstorms, and
 - (b) Cherrapunji and Dacca reported thunderstorms.

Weather under (a) corresponds to the convergent zone in the northeast Assam and weather under (b) corresponds to the zone in East Pakistan and adjoining south Assam and Tripura.

- (ii) Thunderstorms had occurred extensively during the evening—

mostly in the 1430 IST field of convergence.

23 March 1955—At 0730 IST there were two zones of convergence—one in the northeast Assam and the other in the East Pakistan and adjoining Tripura State. The two fields were separated by a field of pronounced divergence. The two phases of weather were—

- (i) In the morning Mohanbari and Sibsagar reported thunderstorms. This weather corresponds to the zone of convergence in northeast Assam. Extensive cloudiness also occurred in East Pakistan, south of Khasi hills.
- (ii) A few thunderstorms had occurred in the evening in the field of convergence of the 1430 IST pattern.

24 March 1955—At 0730 IST convergence was taking place over region north of 25°N with maximum values in the neighbourhood of Garo and Khasi hills. At 1430 IST the field of convergence north of 25°N was restricted between 92°E and 95°E while south of 25°N the entire region was a convergent field. Thunderstorms occurred extensively in the afternoon/evening in the field of convergence of 1430 IST pattern.

25 March 1955—At 0730 IST there lay two fields of convergence—one covering almost the half of upper Assam with a core in northeast Assam while the other was in East Pakistan—the two being separated by a field of pronounced divergence. At 1430 IST over region between 90°E and 94°E convergence was taking place with maximum values over Garo and Khasi hills and their northern neighbourhood. There were two phases of weather—

- (i) In the morning Mohanbari, Sibsagar and Lilabari reported thunderstorms.
- (ii) The second phase of thunderstorm activity commenced at 1530 IST mostly within the field of convergence of 1430 IST pattern.

It will be seen from the above discussions that thunderstorm activity was relatively more pronounced both in the morning and in the afternoon/evening in the areas where marked convergence at 1.5 km level was present. This point is particularly borne out from the fact that inspite of orography of the areas under study there was no thunderstorm activity in the area which clearly showed divergence at the same level.

The configuration of the region under study consists of, in addition to the plains in the west and in the southwest, the hills and the intersticed valleys. Bleeker and Andre (1951) have found an increase in lower level convergence over the plain areas east of the Rocky mountains in the early morning hours. Ramaswamy (1956) and others have pointed

out the role played by insolation and orography in producing afternoon and evening thunderstorms in northeast India (which includes the region). The difficulty in assessing quantitatively the contributions made by topography, insolation and increased nocturnal convergence (found by Bleeker and Andre 1951) will be readily appreciated. Nevertheless, the present study reveals that a computation of convergence at 1.5 km level alone marks out the potential areas of most pronounced thunderstorm activity both in the morning and in the evening.

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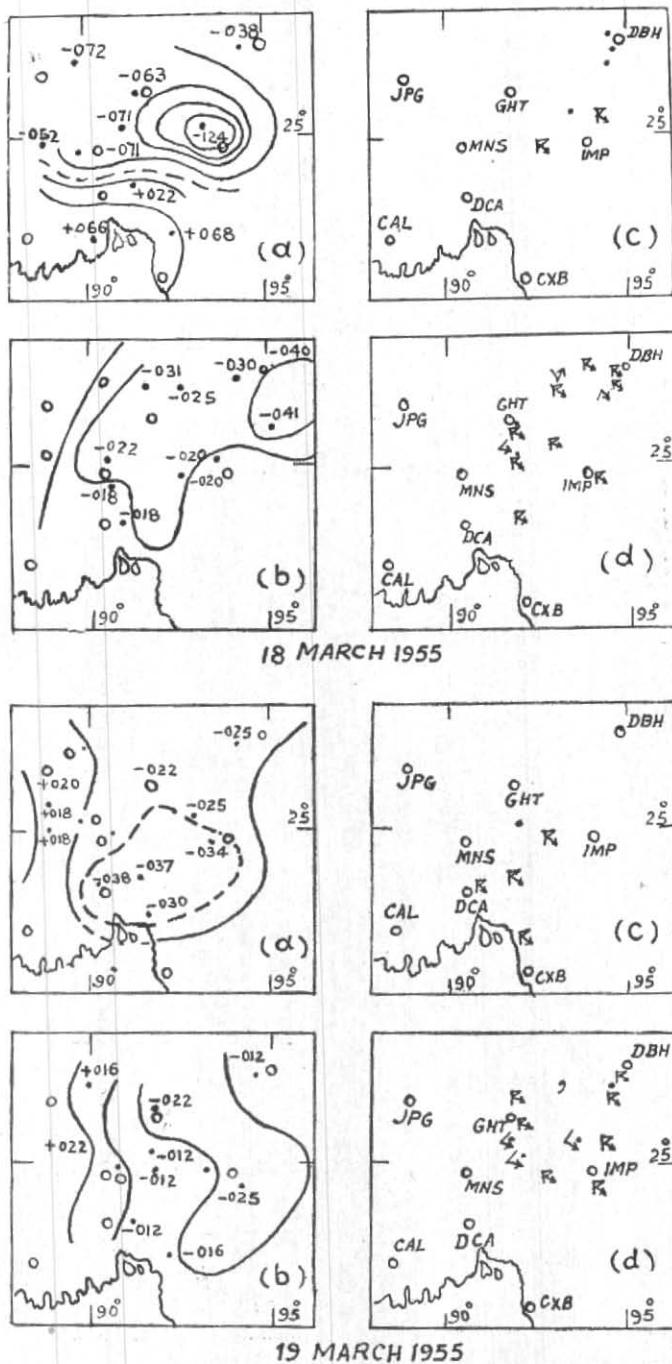
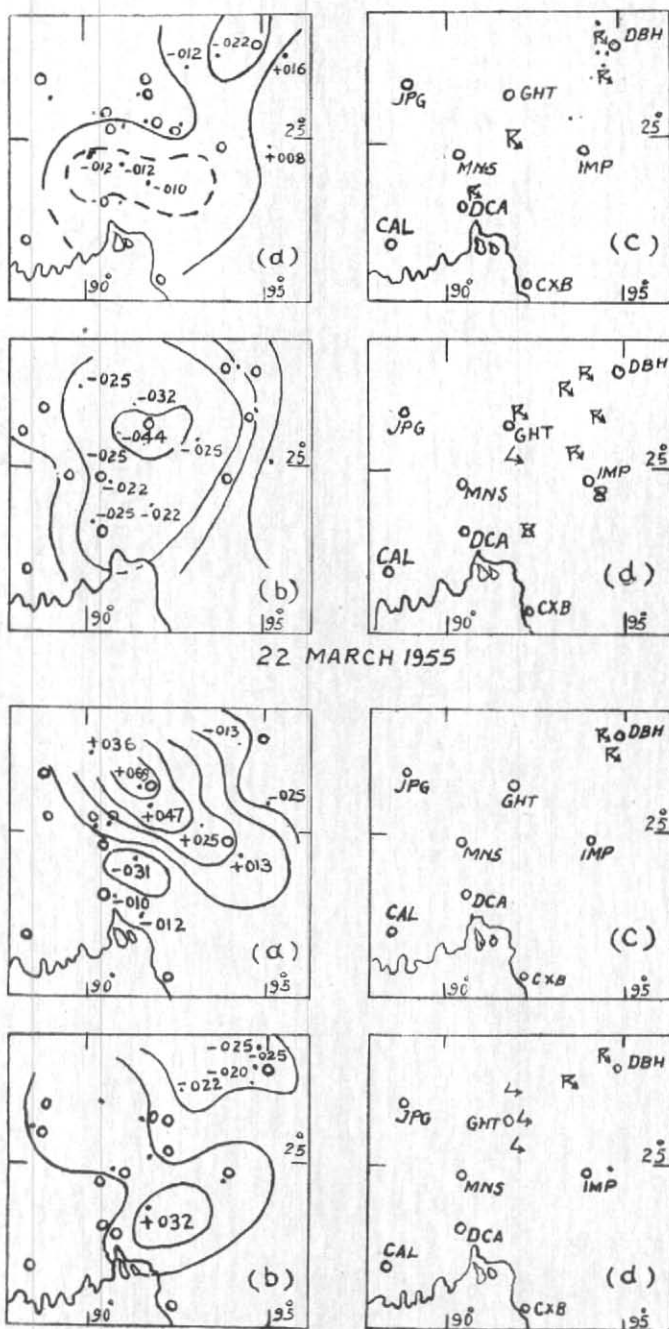


Fig. 1



22 MARCH 1955

23 MARCH 1955

Fig. 3

