

Hailstorm over Telangana

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सार — 11-13 मार्च 1981 के दौरान तेलंगाना और उसके निकटवर्ती क्षेत्र भीषण ओलावृष्टि से प्रभावित हुए जिसके कारण जान और माल का व्यापक नुकसान हुआ। इस शोध-पत्र में सिनॉप्टिक स्थितियों का वर्णन करने का प्रयत्न किया गया है। यह देखा गया है कि यह ओलावृष्टि स्पष्ट उपरि पवन अभिसारी से सम्बद्ध थी जो कि एक जेट धारा जेट क्रोड के भ्रंश में स्थित अक्ष जेट धारा में एक द्रोणिका की गतिशीलता और प्रबल उर्ध्वदिश पवन-अपरूपता ने प्रदान की थी। विषम विद्योपताओं वाली निम्न स्तरी अपसारी और अन्योन्य क्रिया बंगाल की खाड़ी और अरब सागर पर निम्न स्तरी प्रतिचक्रवात और उत्तर-दक्षिण अभिउन्मुखी द्रोणी और/या उत्तर-दक्षिण निम्नस्तरी उपरिपवन द्रोणी/क्षेत्र पर पवन असांत्यता सहित सतह निम्नदाब वाला क्षेत्र प्रस्तुत किया गया।

ABSTRACT. During 11-13 March 1981 Telangana an neighbourhood was affected by severe hailstorm that caused extensive damage to life and property. In this paper an attempt has been made to bring out the synoptic situations. It has been observed that the hailstorm was associated with marked upper air divergence, which was provided by a jetstream, movement of a trough in the jetstream with axis located in the break of jet-core and strong vertical wind-shear. The low level convergence and interaction of airmasses of contrasting characteristics were provided by low level anticyclones over Bay of Bengal, Arabian Sea and surface low pressure area with north-south oriented trough and/or north-south low level upper air trough/wind discontinuity over the area.

1. Introduction

During 11-13 March 1981 there was widespread hailstorm activity over Telangana and neighbourhood. According to State Government Revenue officials, including State Ministers and MLAs, over 470 villages of 56 taluks in about 13 districts of Andhra Pradesh were affected by hailstorm during these three days. The hailstorm caused damage to standing crops in about 33,000 acres, damaged 85,000 houses and taken a toll of 18 human lives and about 13,000 livestock. The damage occurred mostly in the districts of Nizamabad, Medak, Mahabubnagar and Nalgonda. According to press reports and the State Government officials the size of the hail ranged from 100 gm to about 1200 gm in weight and lasted from 10-30 minutes in the afternoon (4 PM to 6 PM).

In the present paper, a study of the synoptic situations leading to the hailstorm has been made.

2. Synoptic situations

From the study of synoptic charts it has been observed that a western disturbance moved away eastwards across Western Himalayas on 9 March 1981, and a fresh western disturbance observed over north Pakistan and adjoining Jammu & Kashmir as an upper air system

on the same day with an induced low over Rajasthan. The upper air system moved away eastwards across Western Himalayas on 11 March, while the induced low lay over northeast Madhya Pradesh with associated upper air cyclonic circulation extending up to 2.1 km a.s.l. On 12th the induced low moved southwards and lay over central parts of Madhya Pradesh, and on 13th the induced low shifted further southwards to central Madhya Pradesh, Vidarbha and Marathwada. On 12 March another feeble low pressure area lay over north Gujarat and neighbourhood with associated upper air cyclonic circulation extending up to 2.1 km a.s.l., which persisted on 13 March over the same area. On 14 March both these systems became unimportant.

At 0.9 km a.s.l. an anticyclonic circulation lay over Bay of Bengal from 9 to 13 March, and another anticyclonic circulation over Arabian Sea during 9-12 March. The axis of trough/wind discontinuity at 0.9 km a.s.l. passed through Aurangabad, Gadag, Trivandrum on 9th; from southeast Madhya Pradesh to extreme south Peninsula on 10th; from northeast Madhya Pradesh to south Tamilnadu through Vidarbha, Telangana, Karnataka, with embedded circulation over Karnataka on 11th (Fig. 1); on 12 March, it extended from east Gujarat to south Kerala across Marathwada, Telangana and persisted on 13th, and became unimportant on 14th.

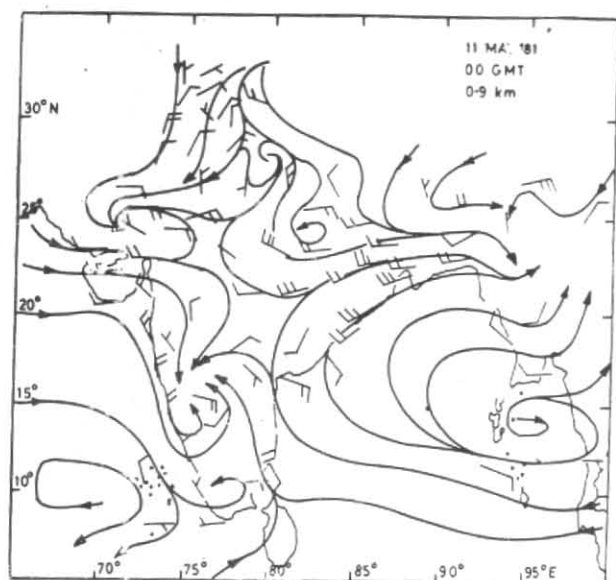


Fig. 1. Upper air analysis at 0.9 km a.s.l. on 11 March 1981 to indicate low level convergence

TABLE 1

Date (Mar '81)	Time (GMT)	Showalter's index	George's index-K
9	00	-1.6	35.7
	12	-2.5	34.4
10	00	+1.0	30.1
	12	-3.1	37.4
11	00	-1.0	29.6
	12	-1.4	34.2
12	00	0.0	30.5
	12	+0.3	33.9
13	00	-4.2	32.1
	12	-4.8	34.9
14	00	0.0	29.2
	12	-3.6	30.9

(+ve values indicate stability and -ve values indicate instability in Showalter's index)

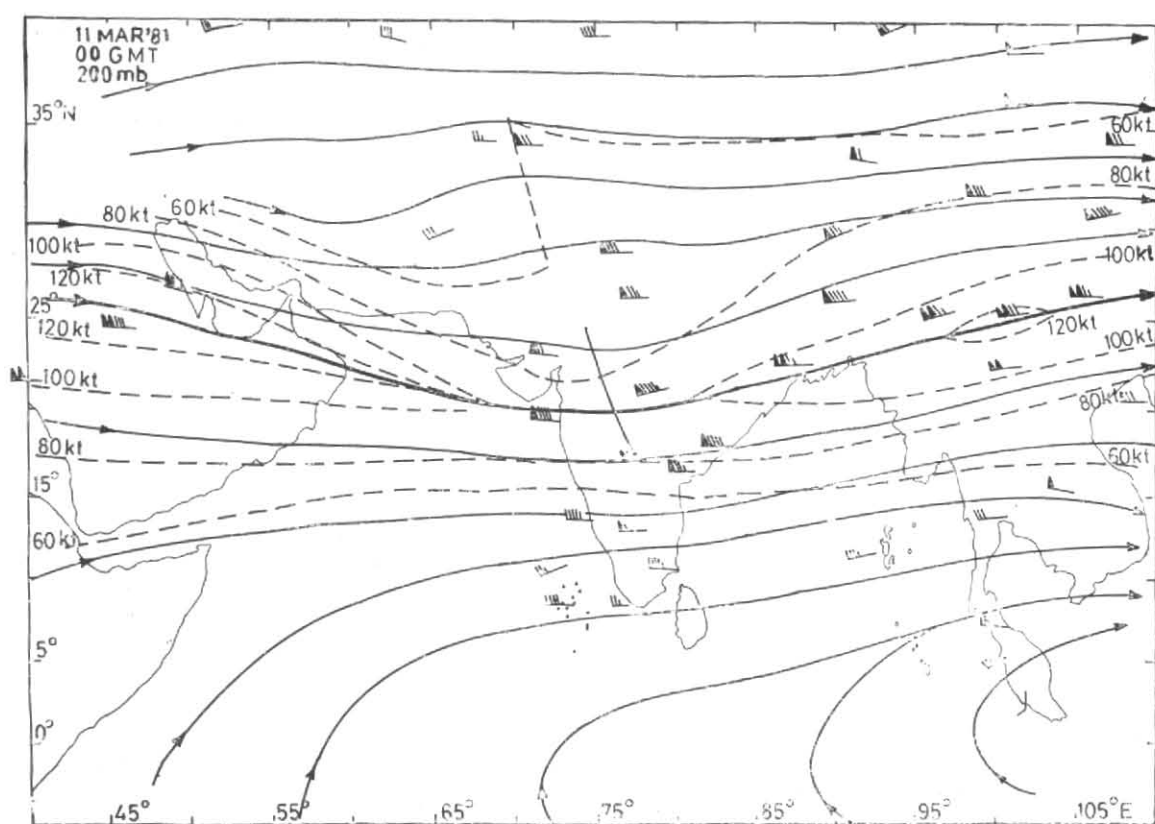


Fig. 2. Upper air analysis at 200 mb on 11 March 1981 indicating trough in the jetstream and location of axis in the jetcore break

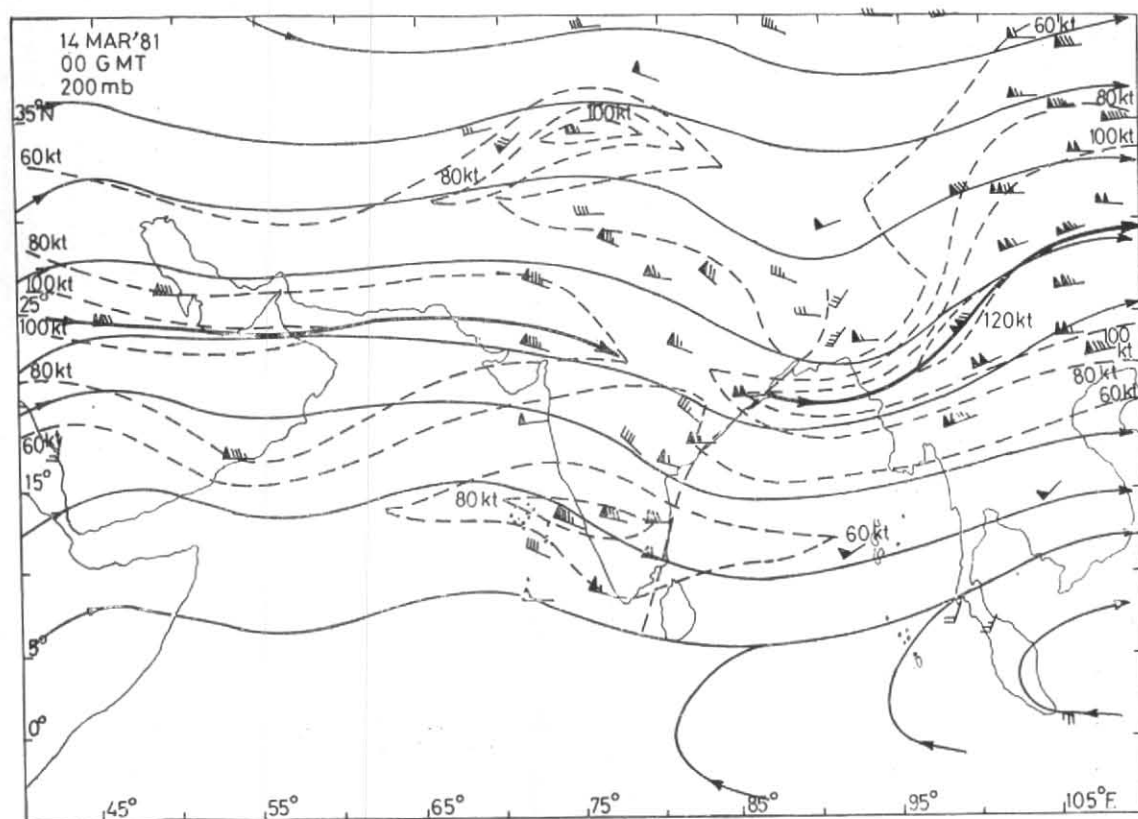


Fig. 3. Upper air analysis at 200 mb on 14 March 1981 indicating eastward movement of trough in jetstream

Under the influence of these low level systems a steady moisture incursion took place over Telangana and neighbourhood which was observed by the rise of dew point temperatures from 4° to 12°C.

At 200 mb level it was observed that there was a break in the axis of jet-core of 100 kt or more over Telangana and neighbourhood. The axis of trough in the zonal westerlies of 80 kt or more at the same level was passing through the jet core break, which moved eastwards from 11-14 March 1981 (Figs. 2 & 3).

3. Vertical time section of Hyderabad

A study of the vertical time section of Hyderabad (Fig. 4), a representative station of Telangana, for the period 9-13 March 1981 reveals the movement of a trough in the zonal westerlies. It also shows that the height of wind maxima increased from about 10.2 km on 9th to about 16.2 km on 13th and then decreased to about 12.8 km on 13th evening. The speed of wind maxima on these days was observed to be about 95 kt.

Showalter's stability index and George's instability index-*K* have been calculated for the period 9-14 March 1981 for Hyderabad, as was done by Singh & Agnihotri (1974), and these values are given in Table 1. These indices show instability on 11 & 13 March, however, Showalter's index does not show instability on 12th; while George's index shows instability.

4. Vertical wind shear over Hyderabad

The vertical wind shear over Hyderabad between 500 & 200 mb levels on 11-13 March 1981 were found to be 50, 45 and 50 kt respectively. The vertical wind shears

between 850 & 200 mb levels on 11-14 March 1981 were found to be 82, 71, 91 and 41 kt respectively, while the normal wind shear between these levels for March is 23 kt. It may be observed that the shear between 850 & 200 mb levels during the hailstorm period was 3 to 4 times the normal. The vertical wind shears between 500 & 200 mb levels at Gannavaram on 11-13 March were found to be 50, 40 and 20 kt respectively, while for Nagpur for the same levels on 11 and 13 March were found to be 85 and 35 kt respectively.

5. Dew point temperatures

It is evident from the dew point temperatures over Telangana and neighbourhood (Fig. 5—represents a typical day) that there was an interaction of airmasses of contrasting characteristics, which is potential for cyclogenesis. Further, the dew point temperature distribution shows a narrow tongue of high dew points jutting into eastern and central parts of Andhra Pradesh where the hailstorms have occurred.

6. Discussion

According to Koteswaram and Srinivasan (1958), "Pronounced upper divergence may be associated with, (i) a trough or a ridge, (ii) a straight jetstream, (iii) a trough (or ridge) with an embedded jet and (iv) an anticyclonic vortex" and it was considered preferable to rely upon vertical time sections for indicating the passage of upper troughs in jets over a station".

According to Griffith and Summers, "a number of factors must be considered simultaneously and it is possible that a non-linear combinations of parameters will be required. For example, wind shear plays

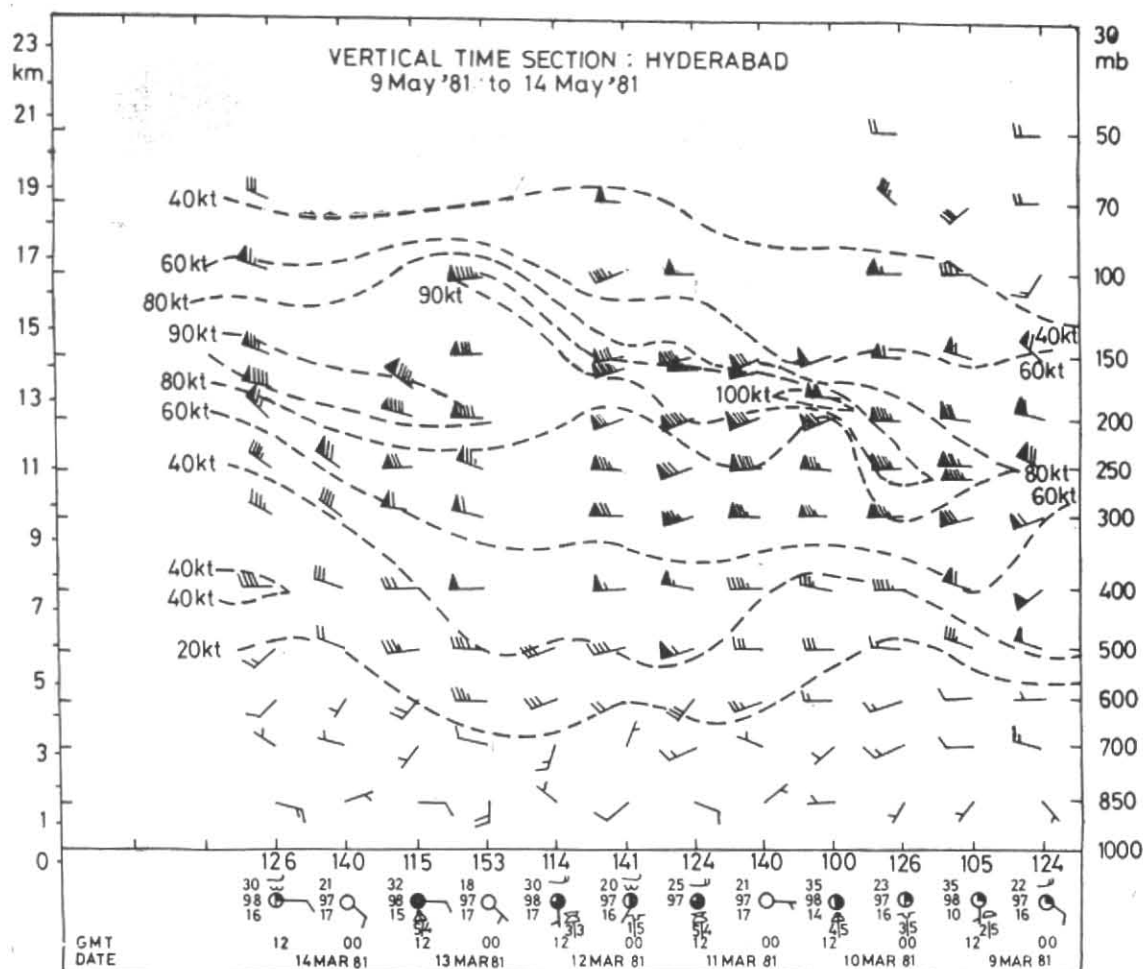


Fig. 4. Vertical time section of Hyderabad, 9-14 March 1981

a role in the organisation of the most severe hailstorm, but it is likely that if shear is too strong, storm development will be inhibited. A major source of non-linearity in the forecasting problem is the existence of several distinct types of hailstorms. Some principal defined types are, (a) an airmass or pulsating multiple bubble storm (Ludlam 1959), (b) a multicell storm (Renick 1971) and (c) a large severe super cell storm (Browning and Ludlam 1962)".

"The first requires great thermal instability and occurs in the absence of wind shear or strong winds. The second requires moderate to strong instability and a proper vertical wind profile. The third type may occur without great instability, requires strong winds with a properly organised vertical profile and is associated with a strong organised downdraft fed by rain cooled air from the middle troposphere. It can produce very large stones, great crop damage and severe wind damage. It seems to be a type of storm associated with tornadoes (Browning and Donaldson 1963)".

According to Stanely & Newton, "divergence exists in the general region from a trough to the downstream crest in upper tropospheric wave. In a sinusoidal wave, maximum upper level divergence is located about

mid-way between trough and ridge. Its intensity is greatest for waves with short lengths and large amplitudes and large wind speed in the jetstream".

Newton and Newton (1959) proposed that the importance of strong winds aloft and the accompanying strong wind shear lines in the dynamic pressure fields generated by the wind blowing against the storm column. Shear determines the vertical gradients of these pressures. When the wind increases with height these gradients cause negative vertical accelerations upward and positive downward. For a typical severe storm wind profile, these forces favour development and propagation of the storm on its front right flank.

According to Eagleman (1983), "the jetstream is a major factor in the development of severe thunderstorms. The jetstream is important because the conservation of angular momentum with available energy transferred from the large circulation down to smaller circulation, thus providing a source of energy for the severe thunderstorm and tornadoes. The strong winds supplied by the jetstream around the thunderstorm are important in initiating and maintaining rotation within the severe thunderstorm; thereby feeding energy directly into an individual thunderstorm".

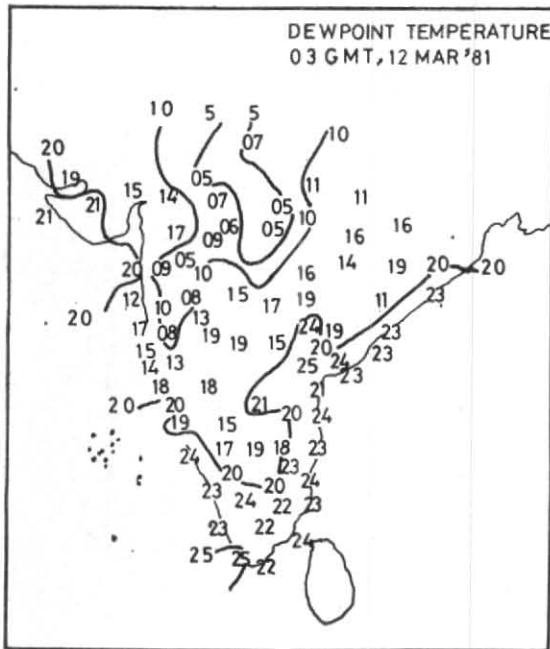


Fig. 5. Dew-point temperature analysis on 12 March 1981 indicating narrow tongue of high dew points jutting into eastern and central parts of Andhra Pradesh

A study of Modahl (1969) showed that wind speed from surface to 500 mb was very different from that compared to the wind speed from 500 mb to 250 mb. The difference between the two was related to the size of the hailstones produced. A wind shear of 65 kmph (35 kt) between the two layers correspond to heavy hail, 61 kmph (33 kt) of moderate hail and 48 (26 kt) to light hail. A wind shear of 44 kmph (24 kt) or less was related to no hail formation. This showed direct relationship with greater wind shear more likely to produce large hail.

Analysis of upper wind charts of 200 mb level (Fig. 2) for 11-13 March 1981 and the vertical time section of Hyderabad for 9-13 March 1981 bring out the following upper air features that provided strong upper air divergence over the area under consideration :

- (i) A break in the jet core axis (Fig. 2),
- (ii) A trough in the jetstream with axis which passed through the break in the jetcore (Fig. 2),
- (iii) Movement of a trough in the strong zonal westerlies (Figs. 2 & 3) and
- (iv) Strong vertical wind shear of the order 70-90 kt between 850 & 200 mb and 40-50 kt between 500 & 200 mb.

Analysis of sea level charts, surface dew point charts and upper wind charts at 0.9 km a.s.l. during the period 9-13 March 1981 reveal the following synoptic situations that provided low level convergence and interaction of

airmasses of contrasting characteristics over Telangana and neighbourhood :

- (i) Surface low pressure area and/or trough,
- (ii) Interaction of airmasses from northwest India, Bay of Bengal and Arabian Sea and
- (iii) Low level circulation and/or trough/wind discontinuity (Fig. 1).

On 14th morning, it was observed that winds at 200 mb level (Fig. 3) considerably decreased in strength, viz., 40-50 kt with change in direction from nearly westerly to northwesterly and eastward movement of trough axis in zonal westerlies, indicating the weakening of wind shear and upper air divergence. Further, it is also observed that the low level systems over Telangana and neighbourhood became unimportant. This resulted in the destruction of low level convergence. These features resulted in the subsequent improvement of weather over Telangana and neighbourhood.

7. Conclusion

From the above study it can be inferred that the occurrence of widespread hailstorm over Telangana and neighbourhood was associated with the following synoptic features :

- (i) A break in the jet core axis,
- (ii) Trough in the jetstream, with axis located in the break of jet core,
- (iii) Eastward movement of trough in the jetstream,
- (iv) Strong vertical wind shear of the order 70-90 kt between 850 & 200 mb and 40-50 kt between 500 & 200 mb levels.

The above features provided the strong upper air divergence.

Low level convergence and interaction of airmasses of contrasting characteristics was provided by :

- (i) Low or induced low over Gujarat and/or Madhya Pradesh,
- (ii) North-south oriented trough on sea level chart over Telangana and neighbourhood,
- (iii) Low level anticyclones over Bay of Bengal and Arabian Sea and
- (iv) North-south oriented upper air trough/wind discontinuity over Telangana and neighbourhood.

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