551·576·12 : 551·515·4 : 551·557 (545) "1975·03·10"

SATELLITE STUDY OF DEVELOPMENT OF SEVERE THUNDER/HAILSTORMS OVER SOUTH PUNJAB ON 10 MARCH 1975

In the afternoon/evening 10 of March 1975, violent thunder/hailstorms were reported from a number of places in the Punjab and Himachal Pradesh. Considerable damage to life and property was reported from a tornado which hit some villages near Ludhiana at about 1700 IST. Within a span of 20 minutes, the tornado with a hanging funnel destroyed/damaged about eight hundred houses, killed ten persons and injured about one hundred and fifty. Besides, considerable damage was caused to trees, electric poles and standing crops. Even a bullock cart with two bullocks was bodily lifted and thrown at a distance killing the animals and injuring the driver.

2. Looking into the causes of this severe weather activity, it was observed that a western disturbance

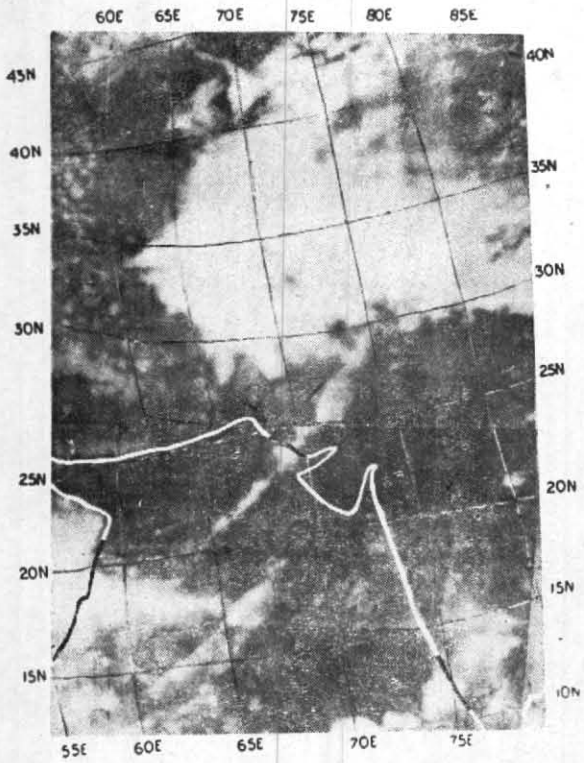

Fig. 1. ESSA-8 APT picture of 10 March 1975

which was located over south Pakistan and adjoining Rajasthan at 1200 GMT of 9th had moved NE and was over the Punjab and adjoining central Pakistan at 0300 GMT of 10th. By 1200 GMT of 10th it was located over the Punjab and Himachal Pradesh. In association with this system, vigorous incursion of moisture took place over the Punjab on the 10th. An idea of this incursion can be had from the change in the wind field. At 1200 GMT of 9th Delhi and Ambala reported light ENE'lies at 1·5 km, indicating that the Punjab was entirely under the influence of dry air upto 9th. By 10th morning, however, (Fig. 2) the flow in this region had become southeasterly and Ambala reported a wind strength of 40 knots at 2·1 km. In fact, a look at Fig. 2 shows that moisture incursion from the Arabian Sea had become vigorous by this time and was maintained upto 10th evening (Fig. 3). As a result of this incursion the satellite picture of 10th morning (Fig. 1) showed development of unstable squall line clouds from the mid Arabian Sea to the Punjab, an indication that strong instability had been created in this region. In fact, the appearance of squall line clouds in the morning satellite picture was a good indicator of the possibility of severe weather development in the afternoon/evening when the atmospheric instability is further enhanced due to insolation.

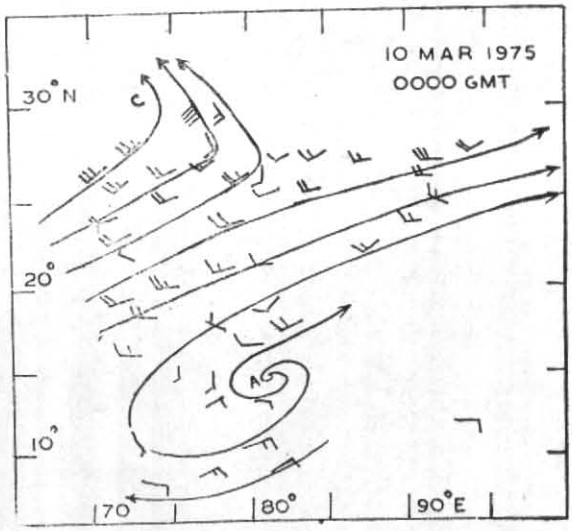

Fig. 2. Upper wind chart, 2·1 km

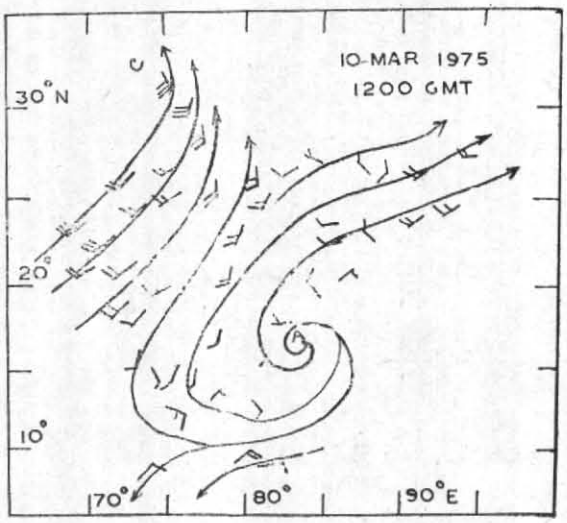

Fig. 3. Upper wind chart, 2·1 km

3. The additional factor needed to help the development of severe weather in this region was the existence of a suitable field of upper level divergence. And that was provided by the sub-tropical jet stream. Fig. 4 shows axis of the sub-tropical jet, at 1200 GMT of 10th. It can be seen that the jet core is located over Jodhpur. The region of south Punjab is, thus, coming in its left hand exit which is a very favourable area for weather development (Riehl 1952). It has been noted that "tornadoes occurring in the presence of sub-tropical jet stream are normally beneath its inter-section with the squall line and to the north of the jet axis" (Anderson *et al.* 1969).

4. Another important factor in the development of severe weather, particularly the development of hail, is connected with the marked wind shear in the vertical from the lower moist layer to upper

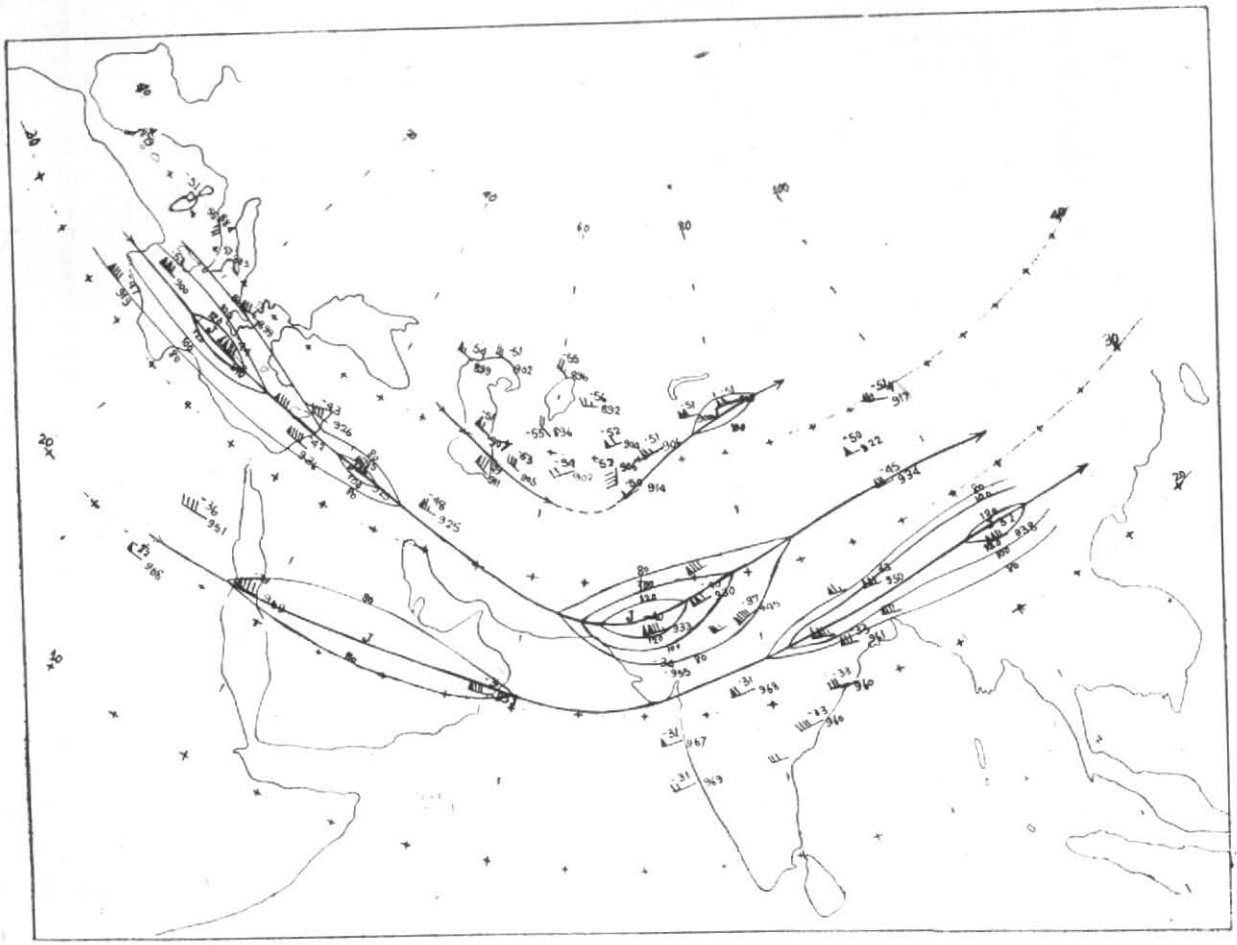

Fig. 4. Upper air chart 300 mb, 1200 GMT on 10 March 1975

dry layer (Saha *see Ref*). If we note the low and high level winds in the south Punjab at 1200 GMT of 10th, we can see that at 2·1 km the wind is 180°/30 kt (Fig. 3) and at 9 km the wind is 250°/80 kt (Fig. 4).

Thus a veer of almost 70° took place between 2·1 and 9·0 km, a clear indication of the possible severe weather activity.

In short, it can be stated that for the forecast of severe thunderstorm development, the following factors may be considered :

(1) Appearance of squall line on the satellite picture.

(2) Strong inf low of moisture at lower levels showing a distinct tongue of moisture maximum.

(3) The superposition of the sub-tropical jet over the squall line. The most prone areas are :

(*a*) the left exit of the STJ,

(*b*) the right entrance of the STJ,

(*c*) the area of the inter-section of the squall line with the STJ.

5. Strong veer of wind with height from the lower moist layer to upper dry layer.

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