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Severe floods in Jammu & Kashmir in August 1973

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ABSTRACT. Occurrence of severe flood in Jammu & Kashmir in August 1973 has been reported. The meteorological situations responsible for such a severe flood have been studied. It is shown that floods in Jammu & Kashmir can occur even in the absence of monsoon depressions and western disturbances but under the favourable influence of (*i*) deep penetration of monsoon air into the area and (*ii*) high level trough-jet system.

1. Introduction

During the period 6 to 10 August 1973 the whole of Jammu & Kashmir (J & K) had continuous rains, with heavy to very heavy falls at a number of places on 9th leading to one of the severest floods in living memory. The floods not only devastated large areas of J & K but also huge areas of Punjab and Pakistan leading to the declaration of emergency by Pakistan Government to counter the ravages of floods.

The interesting feature of this flood is that it was not caused by any monsoon depression recurving northeastwards and breaking up over the Western Himalayas. In fact, this flood was not even the result of an active low pressure area moving across Punjab, north or northeastwards. Further there was no western disturbance as evidenced by the absence of cloudiness to the west of J & K and Punjab (India). The magnitude of the floods can be realised when we see that in two days, places like Qazigund, Banihal, Reasi, had rainfall 16, 18, 23 cm respectively and Jammu and Udhampur had 39 and 38 cm respectively of rainfall in a three-day period. Even a far away station as Khalatse (Lat. 34° 15'N, Long. 76°50'E) recorded appreciable amounts of rainfall during the whole of this period. It is also of interest to note that on 9 August the whole of Jammu & Kashmir State (except probably Ladakh from where the observations are sparse) had heavy to very heavy rains as can be seen from Table 1.

2. Synoptic situation

During this period when J & K had continuous rains and floods there was no system such as a chart low pressure area or depression on the sea level. However, on 5th evening at 850 mb a cyclonic circulation lay over northeast Rajasthan and adjoining west Uttar Pradesh. This circulation is apparently the result of the intensification of the monsoon trough under the influence of an easterly wave trough at 600 mb at 00 GMT of 4th. While there is no circulation on 4th as evident from Fig. 1 (a) the monsoon trough has given rise to a cut-off low at 850 mb Fig 1 (b). under the favourable positive vorticity advection associated with the easterly trough (Fig. 2). The cyclonic circulation moved northwestwards and lay over north Rajasthan and adjoining Haryana on 6th evening. It further moved northwestwards and lay over north Rajasthan and adjoining parts of Pakistan. It later recurved and lay on 8th morning over Punjab and adjoining north Pakistan. Continuing to move northnortheastwards across southern parts of

TABLE 1

Station	Amount of rainfall on 9 Aug 1973 (mm)	Normal for August (mm)
Jammu	273	291
Reasi	208	—
Udhampur	212	—
Banihal	126	60
Gulmarg	111	115
Qazigund	111	51
Verinag	138	—
Shopian	111	—
Kukarnag	122	—

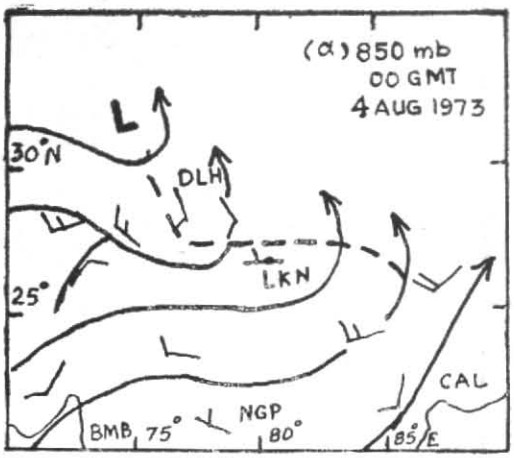

Fig. 1(a)

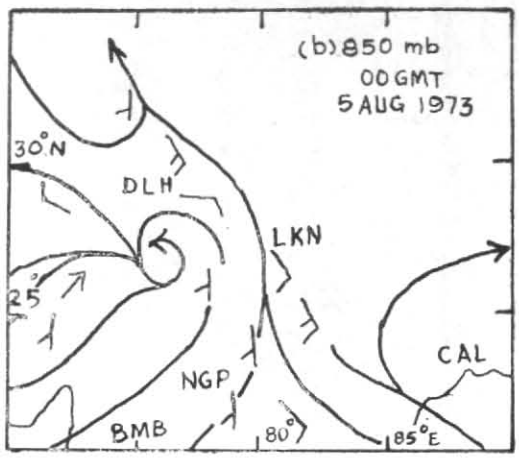

Fig. 1(b)

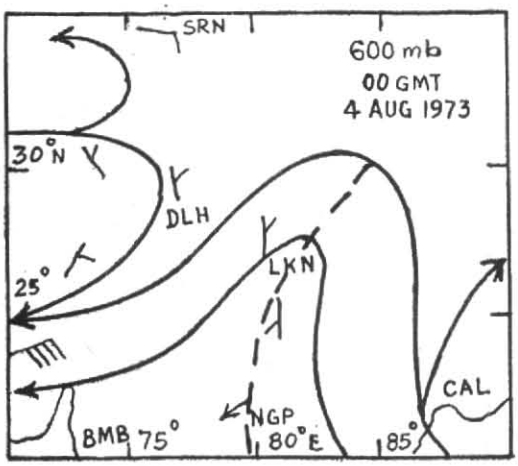

Fig. 2

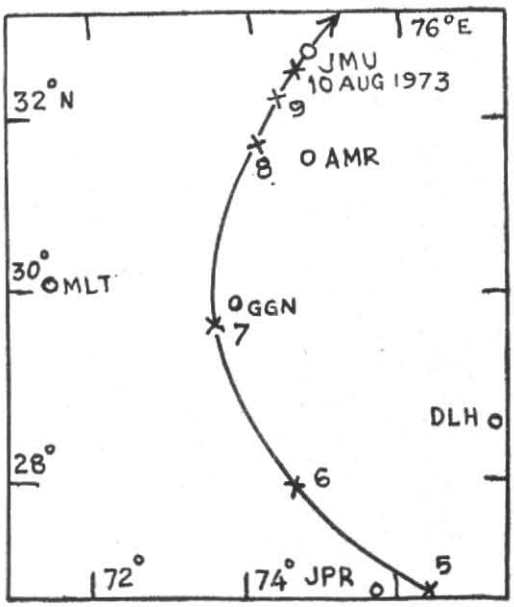

Fig. 3. 00 GMT centres of 850 mb cyclonic circulation between 5 and 10 August 1973

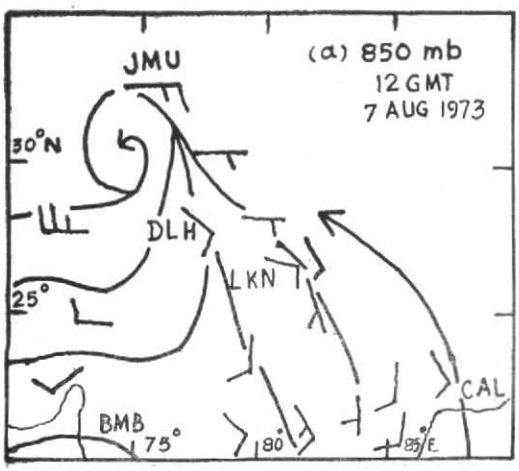

Fig. 4 (a)

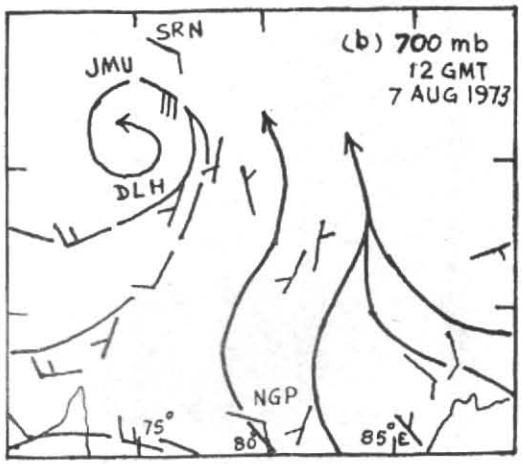

Fig. 4 (b)

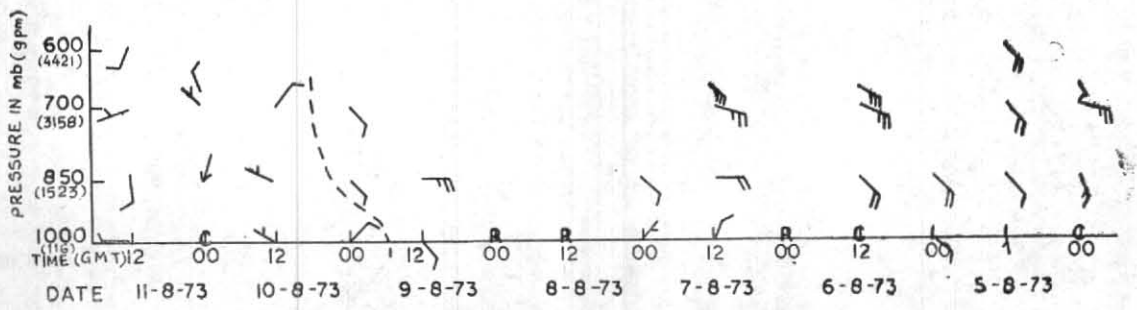

Fig. 5. Vertical time-section of winds of Jammu

Jammu & Kashmir State, it broke up over the Western Himalayas on 10th. Track of this cyclonic circulation is given in Fig. 3. Even at 700 mb a similar sequence of circulations was discernible, though not so clearly due to paucity of data. 850 and 700 mb flow patterns for 12 GMT of 7th are reproduced in Figs. 4 (a) & (b) to clearly indicate the deep penetration of easterlies into Jammu & Kashmir.

Under the influence of this system the monsoon southeasterlies over northwest India had strengthened and penetrated deep into Jammu & Kashmir causing persistent rainfall over the whole State. This system probably extended upto 600 mb but did not positively extend upto 500 mb. Even though the persistent rainfall over Jammu & Kashmir was the result of the 850 and 700 mb circulation systems, several stations in Jammu & Kashmir getting very heavy rains on 9th cannot be attributed to this low level system only. To find out the reasons for these heavy rains, the 300 and 200 mb charts for the whole period were examined.

On 8th morning, at 300 mb, a trough in the westerlies was seen along 66°E extending upto 35°N. On 9th morning, the trough deepened and was along 71°E. This trough could also be seen at 500 mb on 9th morning extending upto 30°N. Subsequently it got damped.

At 200 mb, on 8th morning, a trough in the westerlies lay along 65°E, north of 35°N. The jet axis was seen to have migrated southwards from 45°N and lay along 42°N. The jet core had an increased magnitude from 80 knots of previous evening to 120 knots. Further the jet core commenced right from the trough and lay to its east, whereas the wind speeds just to west of the trough were relatively very weak. On 8th evening, the trough remained along 65°E, north of 32°N but the jet axis further migrated southwards and commenced from 37°N with an eastnortheast orientation and the jet core speed further increased to 140 kt. On 9th morning, the trough moved eastwards and lay along 70°E north of 32°N whereas the jet core shifted slightly northwards to 39°N and decreased in magnitude to 120 knots. By 9th evening, the trough considerably damped without appreciable movement and the jet axis shifted further north to 42°N. By 10th, zonal flow had set in and the jet axis futher shifted to 45°N.

3. Discussion

The continuous rains over Jammu & Kashmir from 6th to 10th were the result of the low level circulation extending upto 600 mb moving across J & K as described above. This low level system is responsible for taking the monsoon air deep into J & K as can be seen from the vertical time-section of winds of Jammu (Fig. 5). Ramaswamy (1965) has also found that deep penetration of monsoon air as far west as Iran leading to flood producing rains, can take place under favourable synoptic situations.

Vertical time-section of Srinagar could not be presented due to ascent failures on crucial days. It is of interest to note that the depth of moist easterlies is upto 600 mb. It can also be seen from the same figure that the circulation (extending roughly upto 600 mb) passed across Jammu only on 10th between 00 and 12 GMT. This explains the continuous rain spell in the whole of J & K till 10th and rapid improvement later.

As regards the heavy to very heavy rans in J & K it is seen that the trough-jet system at 300 and 200 mb migrated southwards between 8th morning and 9th morning and got intensified, so that J&K lay in an area of enormous high level divergence. The 200 mb patterns are presented in Fig. 6. From the above figure it is clear that J&K lay in an area ahead of a westerly trough and in the right entrance of a strong sub-tropical westerly jet. Thus in the present case, the positive vorticity advection due to curvature and shear terms were additive, leading to enormous divergence (Gordon

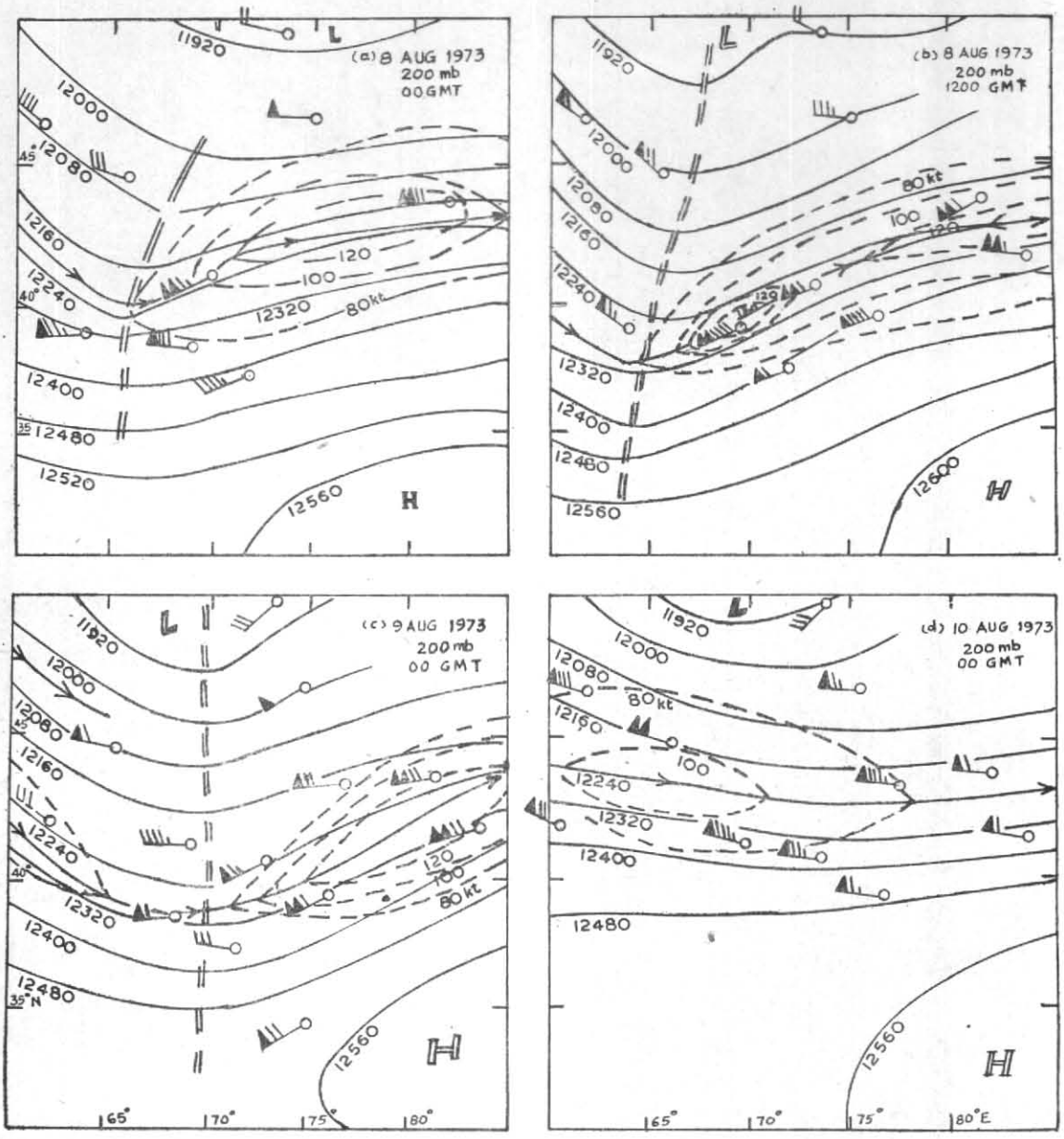

Fig. 6

1962). This combined with the penetration of the monsoon easterlies into J & K by the low level system explains the exceptionally heavy rains recorded on 9th morning at a number of places. With the decaying of the low level system and the northward migration of the trough-jet, as well as the damping of the high level trough the weather over J & K rapidly improved after 10th.

Haltiner and Martin (1957) state "Observations show that rapid intensification of the young extratropical cyclones occurs when the displacement between the sea level cyclone and the upper level wave, say at 300 mbs is large". In the present case, the heavy rains over J & K was caused by the combined effect of a tropical low level system namely the upper air cyclonic circulation between 850 and 600 mb recurving northeastwards and the high level trough-jet. As can be seen from Figs. 3 and 6 while the low level system was near 75°E, the trough at 200 mb was along 65°E indicating a large westward tilt of the vertical axis. While Haltiner and Martin refer to cyclone-trough system in the extra-tropical region, in the present case the low level and the high level systems were separate entities till 8th morning. From 8th evening, the high level system extended downwards upto 500 mb (as stated earlier) while