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HEAVY RAINSPELL DURING JANUARY 1989
OVER NORTHWEST INDIA

1. During winter and pre-monsoon season north India gets rainfall from the eastward moving low pressure systems, referred to as western disturbances. Occasionally, large amplitude troughs moving across Eurasian region in the upper troposphere generate active lower tropospheric vortices over Pakistan and adjoining northwest Indian region which provide copious rainfall over several parts of northwest India. One such active rainspell during January, 1989 has been studied here.

2. *Synoptic features associated with the spell of western disturbances*—There was a large amplitude trough in the westerlies with its axis about 70°E at 300 hPa on 1 January 1989 (Fig. 1). This trough retrograded westward and was along 58°E by 1200 UTC of 4 January 1989 (Fig. 2). A trough with the cold temperature to the west of it is located near 72°E over Indian region on 700 hPa of 1200 UTC of 4 January 1989. The temperatures which were initially cold to the left of the upper tropospheric trough moved to the right after 4 January. Thus the areas of Pakistan, Afghanistan and northwest India were under the continued influence of the forward sector of this trough since 1 January. This induced a series of lower troposphere vortices which could be seen on 850 and 700 hPa charts as well as on msl charts on most of these days. The chart of 700 hPa 1200 UTC of 4 January 1989 (Fig. 3) has been shown as an illustration. On 4 January 1989 the low over msl charts is at 30°N , 67°E and the vortex is seen over 33°N , 67°E on 700 hPa (Fig. 3) and trough behind this vortex. The 300 hPa trough line passes about 57°E (Fig. 2), while 500 hPa trough line extends from Afghanistan to Ganganagar city.

On 5 January 1989 low at msl has remained practically stationary. The associated vortex at 850 hPa 0000 UTC is at 32°N , 65°E and 700 hPa vortex is around 33°N , 70°E . The trough line in the upper troposphere tilts eastwards. The anticyclone in lower tropospheric levels over 850 hPa was centred over Parbhani in Maharashtra which happened to be a favourable position for feeding moisture to the lower level vorticity centres over northwest India. The winds over Veraval, Jaipur, Delhi are southwesterly to westsouthwesterly of the order of 15 kt. The 300 hPa trough is along 62°E north of 25°N (Fig. 4). Due to this anticyclone there was a deep moisture incursion in the northwest sector of this anticyclone. This moisture convergence into the area of positive vorticity enhanced the possibility of heavy rainfall. This situation continued up to 7 January under the influence of a very slow moving southward advancing upper tropospheric trough in the westerlies extending from 20°N to 50°N along 67°E at 300 hPa of 1200 UTC on 7 January. The low pressure area in the lower troposphere was having a tilt northward while the low at 850 hPa moved southeast between fourth and sixth of January.

The satellite imagery of 5 January 1989 shows huge cloud mass over Afghanistan, Pakistan, Haryana, Punjab and Jammu & Kashmir. In view of this, rainfall occurred almost at all the places in Haryana, Punjab and many

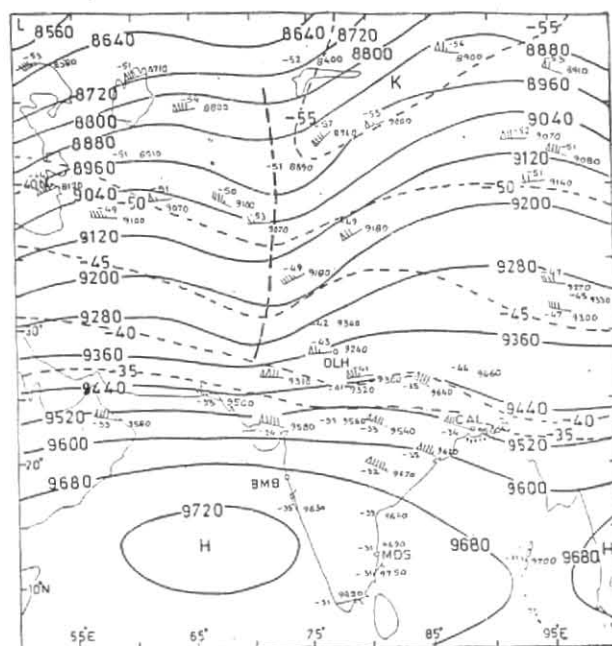


Fig. 1. 300 hPa analysis, 1200 UTC of 1 January 1989

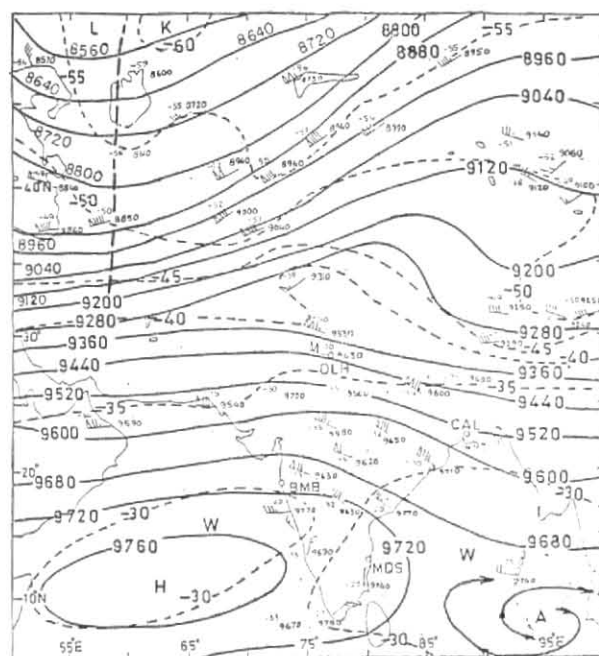


Fig. 2. 300 hPa analysis, 1200 UTC of 4 January 1989

places in west Rajasthan and plains of west Uttar Pradesh on 6 January 1989. On 5 January night temperature rose over Punjab and west Uttar Pradesh. On 6 January night temperatures fell over Jammu & Kashmir and hills of west Uttar Pradesh and rose markedly over west Rajasthan. This was an indication of approaching western disturbance. On 6 January 1989, Udhampur reported 5 cm rainfall, Punjab, Himachal Pradesh and adjoining areas of Rajasthan and Haryana received fairly widespread rainfall. On 6 January anticyclone

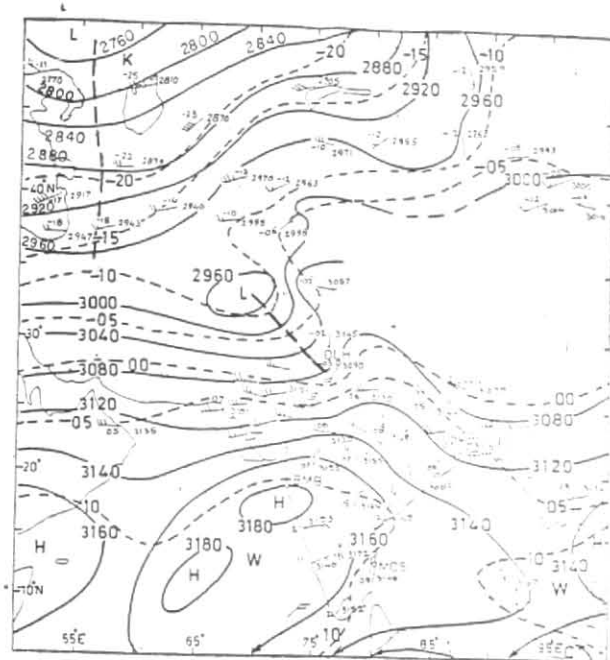


Fig. 3. 700 hPa analysis, 1200 UTC of 4 January 1989

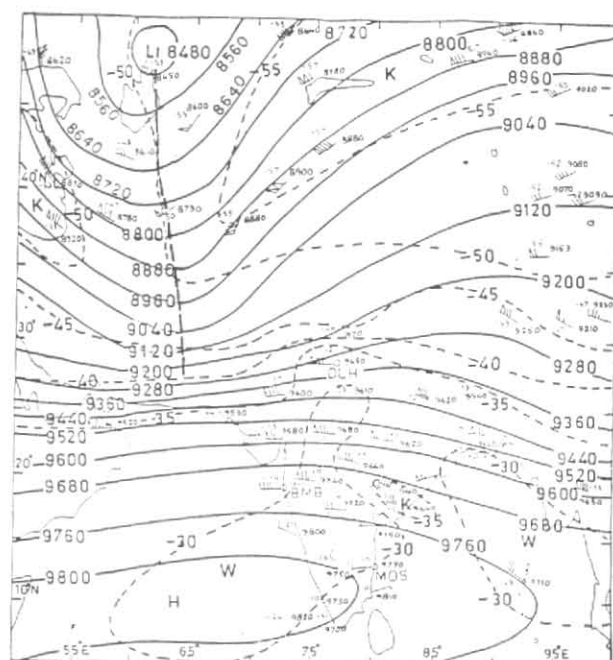


Fig. 4. 300 hPa analysis, 1200 UTC of 5 January 1989

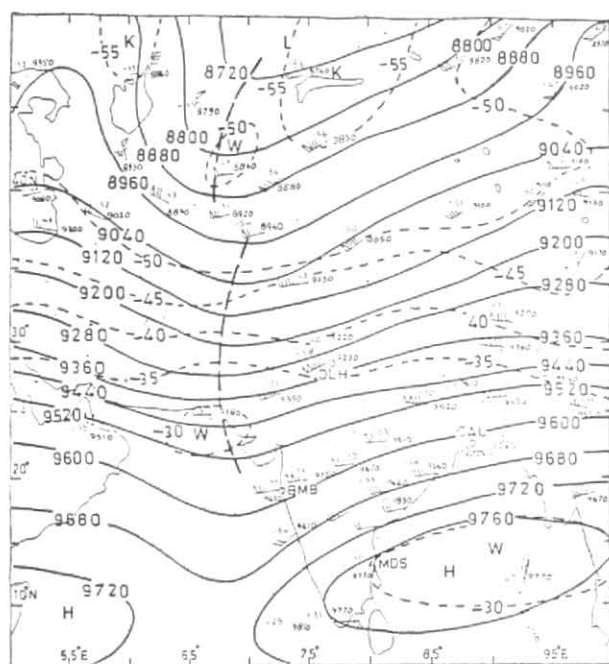


Fig. 5. 300 hPa analysis, 1200 UTC of 7 January 1989

at 850 hPa shifted little eastward. The winds in northwest sector were southwesterly to westsouthwesterly and wind speed increased in strength. The mid tropospheric circulation (33°N , 73°E) is seen around (34°N , 72°E) over msl and around (33°N , 73°E) at 700 hPa. In satellite imagery a trail can be seen from the Arabian Sea to northwest India which may probably be due to moisture transportation from the Arabian Sea. The thermal cold was also seen at 34°N , 74°E . On vertical time section of Delhi, the thermal trough can be seen. The vertical time section of Delhi revealed the continued influence of western disturbance there during 1 to 3 January and 5 to 7 January. Winds were backing with height in the lower troposphere, indicating cold air advection, this enhanced the convective activity. Rainfall was reported at almost all the places in Haryana and at many places in west Rajasthan and plains of west Uttar Pradesh on the following morning.

The vortex was over 30°N , 74°E on 7 January, 1200 UTC msl. The associated circulation can be seen extending up to 7.6 km a.s.l. The supporting trough was also about 67°E at 300 hPa (Fig. 5). There was a continuous moisture feed from Arabian Sea in the lower tropospheric levels as winds were southwest to westsouthwesterlies right from Veraval to Delhi. The winds ahead of trough line and in northwest sector of anticyclone over north Peninsula in the lower tropospheric levels were

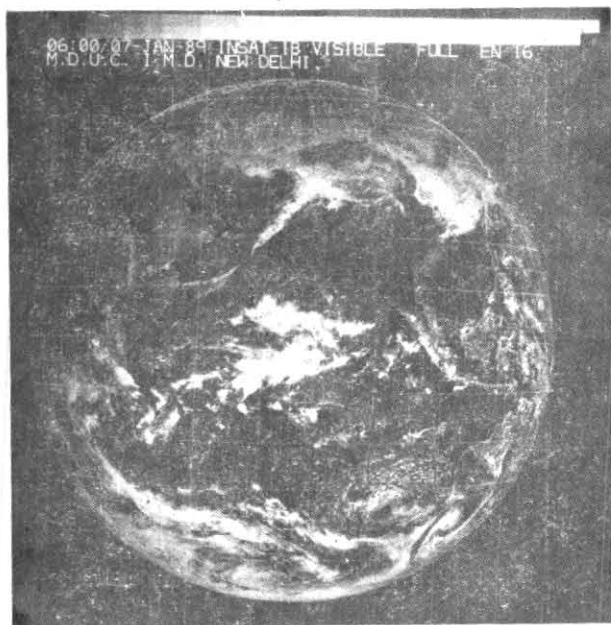


Fig. 6 INSAT-IB cloud picture (visible) of 0600 UTC of 7 January 1989

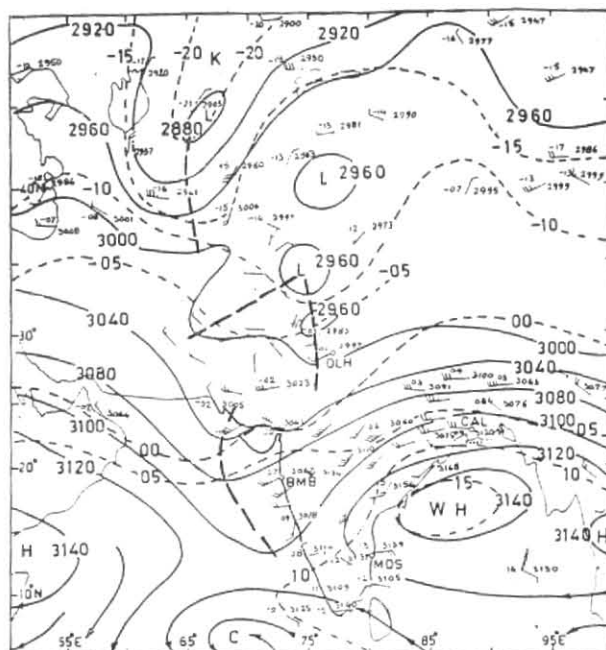


Fig. 7. 700 hPa analysis, 1200 UTC of 7 January 1989

quite strong. At 850 hPa winds were of the order of 15 to 20 kt while at 700 hPa (Fig. 7) around 40 kt, Bhopal has reported 65 kt southwesterly at 700 hPa. The visible satellite picture of 0600 UTC of 7 January 1989 (Fig. 6) showed a strip of cloudiness running from the Arabian Sea covering Gujarat, Rajasthan, Haryana, Punjab and Uttar Pradesh. Under the influence of these synoptic features the rainfall occurred at almost all the places in Haryana, many places in Punjab, east Rajasthan and Plains of Uttar Pradesh. Delhi reported 6 cm rainfall.

3. Significant amounts of rainfall (cm) on 8 January 1989 were: Jogindranagar 8, Sonapat 7, Chandigarh & Delhi 6 each, Ambala & Dehradun 5 each and several other stations less than 5. The cumulative rainfall distribution for a few stations for 6-8 January 1989 in cm were: Delhi 11, Udhampur, Chandigarh & Dehradun 10 each, Jagadhri, Ambala & Kalka 9 each, Jogindranagar 8, Kandaghat & Sonapat 8 each, Pathankot 7. Many other stations reported less than 7 cm rainfall.

4. *Conclusion*— Approaching large amplitude troughs from Eurasian region tend to generate *in situ* vortices in the lower tropospheric levels and at msl over Pakistan & Afghanistan region and adjoining parts of northwest India. These induced vortices popularly known

as western disturbances are accentuated further due to simultaneous presence of anticyclone over the north Bay of Bengal and adjoining northern Peninsula in the lower tropospheric levels and generate copious rains, occasionally moderate to heavy falls over several parts of northwest India.

References

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