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Unusually early and heavy snowfall over the Punjab Himalayas — A case study

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ABSTRACT. The Lahaul and Spiti valley in the Punjab Himalayas experienced a spell of severe snowfall in the third week of September 1962. This was unusually early for the area. The synoptic features which led to this situation have been described in this paper.

The interesting point revealed in the present study is that the cold air outbreak from an anticyclone moving east and southeast from Ukrainian area in synchronization with the recurvature of the monsoon depression was the main cause of the snowstorm.

The probable influence of the Urals has also been indicated.

1. Introduction

The Punjab Himalayas experienced a spell of severe weather during the third week of September 1962. In the Lahaul and Spiti valley in the Kangra district, unusually early snowfall and avalanches occurred. According to reports as much as ten feet of snow accumulation took place overnight between 20 and 21 September 1962. Thousands of labourers of Punjab P.W.D. engaged in road construction work and officials of the Geological Survey of India were caught unawares. There was an unfortunate loss of human lives when they were trapped in avalanches and marooned. The services of the army had to be mobilized for evacuating the marooned people.

The synoptic conditions which resulted in this havoc are detailed in this article.

2. Synoptic features in Tropics

Under the influence of a low pressure wave from the east, a depression formed in the west central Bay of Bengal on 16 September 1962 with centre about 300 km southeast of Kalingapatam. It intensified into a deep depression on the same day and crossed coast near Gopalpur on the night of 17-18th — the track of the depression is given in Fig. 1. It had a westnorthwestwards movement till 20th. Subsequently it had a northward movement and lay over the south Punjab on the evening of 21st and broke over the hills on the next day. Results of a detailed isohyetal study of this depression for 20-22 September 1962 have been published (India met. Dep. 1963). The recurvature of the depression from 20th onwards could be well anticipated. Workers of the India Meteorological Department have shown that a depression or low pressure area recurves when a marked trough in the westerlies aloft lies to the west of it. The main problem in the present case is the occurrence of snowstorm rather than rainstorm associated with the breaking up of the Bay depression over the Punjab hills. Snowstorm in the Punjab hills during the third week of September is rather too early and is thus of special interest. To understand the mechanism which caused this unusually early snowstorm, the pressure systems over the northern hemisphere have been examined from the synoptic charts prepared at the Northern Hemisphere Analysis Centre, New Delhi. Synoptic charts of the northern hemisphere printed by U.S.S.R. were also made use of. The pressure systems and flow patterns that appeared to have caused the unusual weather over the Punjab hills are briefly described below.

3. Pressure systems and flow patterns in extra-tropical regions

To trace the changes in the flow pattern that occurred in the extra-tropical regions during the period, it is necessary to discuss the systems from 12 September 1962 onwards.

The sea level chart on 12 September 1962 is presented in Fig. 2. It is seen that the Siberian High was well displaced to the east and instead low pressure areas lay there. An intense extra-tropical cyclone lay over North Scandanavia centred about 68°N and 25°E. A ridge of high pressure aloft was developing over the Urals as was seen from the upper air charts of the day (700 and 500 mb charts; not presented). The extra-tropical cyclone moved rapidly southeastwards and it lay on 14 September 1962 over Russia, east of Gulf of Finland centred near 60°N and 40°E. Pressure rose by more than 10 mb over Siberia (central pressure on 14th became more than 1025 mb — Fig. 3), compared to that on 12th. At the upper levels also the ridge of

high pressure continued to be well marked. Thus a well developed trough-ridge system existed over central Asia. At 700 mb on 15th (chart not presented) could be located a well marked cut off 'High' over northeast of the Urals with associated ridge merging into the Tibetan High. The cut off High aloft with the ridge east of the Urals became more prominent on subsequent days. 500-mb chart of 16th is shown in Fig. 4 to bring out the intense blocking aloft east of the Urals.

The situation between 14 and 16 September 1962 seemed similar to the one favourable for cold air outbreak over China as discussed by Staff Members of Academia Sinica (1958). Under the third category of synoptic development discussed by them cold air originated in West Siberia. Extract from their paper is of interest and is as follows —

"During winter a large anticyclone may be stagnant over Western Siberia and Mongolia for many days. The maintenance of this stationary high pressure is related to the blocking over Urals. The air in the high cools through radiation. Gradually it becomes very cold and the surface pressure increases gradually upto a very high value. At last with the collapse of the Ural blocking this intense cold high breaks out southwards and leads to a severe cold weather in China".

But immediately after 16th, the sea level Siberian anticyclone started weakening and receding northwards, whereas the high pressure cell over Ukraine and adjoining areas southwest of Aral Sea developed rapidly between 15th and 16th. The central pressure rose to 1025 mb on 17th (Fig. 5). In the upper level the ridge was developing with axis running approximately along 30°E. The sea level high pressure area over Ukraine continued to be well marked and protruding southeastwards till 20th. Between 20 and 21 September (for comparison sea level charts of 20th and 21st are shown in Figs. 6 and 7), however, the high pressure cell broke southeastwards bringing in cold air which was stagnant over the Ukrainian area, to the northern parts of India.

It may be seen that on 20th (Fig. 9) a cut off low lay centred near 35°N, 72°E with an associated well marked trough running roughly parallel to 72°E. This was a very favourable situation for recurvature of the monsoon depression. Cold air outbreak over northwest India from the Ukrainian High took place between 20 and 21 September 1962. This cold air outbreak was shown by the sudden fall in day and night temperature over the stations of northwest India (*vide* Table 1). It may be seen that most of the stations over the hills of Punjab and adjoining areas recorded a rapid fall of day temperature of more than 10°C at Mandi, 8°C at Bilaspur, about 6°C at Amritsar and 3°C at Delhi between 20 and 21 September 1962. The cold air pervaded over the area almost at the same time when the monsoon depression recurved and broke up over the Punjab hills. Thus the cold air from the Ukrainian anticyclone acted as a wedge and helped in lifting and replacing of the warm moist air in the area associated with the monsoon depression. The effect of this lifting might have two-fold influence. Firstly the lifting causes cooling and also further growth of cloud droplets and secondly the precipitation which falls, has to traverse the lower region of cold air before reaching the ground. Therefore, the hydrometeors which otherwise could be in liquid state fell as continuous snow.

4. Probable influence of the Ural

From the series of the synoptic charts referred to in the article and general experience of analysis in Northern Hemisphere Analysis Centre, New Delhi, it has been observed that there is always a tendency of low pressure systems approaching from west to the Urals to give rise to well marked troughs associated with the systems to protrude southeastwards and in some cases also give rise to cut off low east to southeast of Aral Sea (Figs. 4, 8 and 9 bring out the above fact). This might be the effect of the orography of the Urals which runs 1500 miles almost north-south from Novaya Zemlya in the north to Aral Sea in the south. Another interesting point revealed by the study of the upper air charts for the period 18 to 21 September 1962 (500-mb charts for 18th, 20th and 21st are shown in Figs. 8 to 10) is that an upper air ridge with its axis running approximately along 30° east and a cut off high with associated ridge protruding southwards east of Urals weakened gradually after 18 September and became unimportant between 20th and 21st, *i.e.*, on the day when cold air outbreak from Ukrainian High took place over north India.

This aspect of the problem with special reference to the influence of the Urals on Indian weather and further detailed study of the cold air outbreak over the northwest India in relation to collapse of sea level Ukrainian High will be presented in a subsequent paper.

5. Summary and Conclusions

During the period 20–22 September 1962 the Punjab hills experienced unusually early and heavy snowstorm which resulted in unfortunate loss of human lives. This snowstorm over the

TABLE 1

Day/Night temperatures (°C) — 18-24 September 1962

Station	18th	19th	20th	21st	22nd	23rd	24 Sep 1962
Mandi	30·4	31·7	32·0	21·6	18·4	29·1	29·8
	20·1	21·2	19·1	16·6	16·9	16·1	17·9
Bilaspur	31·8	33·5	31·2	23·0	22·5	31·0	32·0
	21·4	25·1	20·9	16·9	17·5	18·4	19·7
Dharamsala	25·3	27·0	26·2	20·1	21·2	25·1	25·6
	19·5	20·9	18·9	16·4	16·7	17·0	17·3
Mussoorie	19·3	19·7	22·0	17·4	17·0	18·9	21·1
	14·9	15·7	14·6	12·9	13·3	12·3	13·9
Joshimath	21·8	25·2	25·1	21·4	18·3	20·2	19·5
	15·7	15·4	15·2	15·1	13·7	13·3	14·2
Srinagar	29·0	28·5	28·3	23·9	19·4	14·6	17·4
	13·3	15·0	14·7	12·2	9·7	9·1	11·1
Jammu	33·8	34·1	34·7	32·8	23·6	24·4	31·1
	21·9	26·1	23·3	21·7	18·9	18·9	21·4
Dalhousie	21·0	23·5	24·0	22·0	20·5	20·0	24·0
	16·0	17·0	14·5	14·0	12·5	9·0	6·0
Simla	20·6	20·6	18·4	18·0	13·9	17·3	20·2
	14·5	15·5	14·3	12·0	12·0	11·8	13·9
Mukhim	22·9	24·5	23·5	19·7	18·5	22·0	23·3
	15·3	16·3	14·7	13·5	12·8	13·3	14·0
Mukhteswar	17·8	20·1	20·9	17·8	13·9	19·5	18·9
	13·4	14·0	13·4	12·2	10·8	12·1	11·3
Nainital	19·5	21·2	21·2	19·5	16·2	20·6	20·6
	14·4	15·6	16·1	1·7	—1·1	12·2	13·9
Abu	24·8	26·0	25·6	21·7	21·1	23·7	22·9
	16·4	17·4	17·2	16·2	14·3	14·6	14·2
Tehri	32·2	33·8	34·3	26·0	24·0	31·5	32·0
	21·3	23·1	21·7	20·7	19·4	19·2	20·7
Delhi	33·1	34·2	34·5	31·4	26·0	32·6	32·0
	25·2	25·0	26·2	23·6	22·2	23·1	21·9
Pathankot	31·3	33·0	33·2	28·1	21·6	28·8	30·9
	22·1	23·4	21·6	18·4	17·8	18·6	19·1
Amritsar	34·3	34·8	35·6	30·1	21·7	27·6	31·1
	21·2	26·3	24·7	20·9	20·4	22·4	24·0

NOTE — The first and second rows against each station give maximum and minimum temperatures respectively

Lahaul and Spiti valleys (Punjab hills) occurred under the following synoptic situations —

(*i*) Recurvature of a monsoon depression from the Bay of Bengal and its breaking up over the Punjab hills,

(*ii*) Synchronization of the above synoptic development with the cold air outbreak associated with south eastwards extension and breaking up (weakening and spreading) of the sea level Ukraine High of cold air, and

(*iii*) The snowstorm rather than rainstorm over the area occurred under the above synoptic developments. The southeastwards advancing wedge of cold air from the Ukrainian anticyclone lifted and replaced the moist air associated with the monsoon depression at the lower levels and thus the hydrometeors falling through the body of cold air fell in solid state.

The most interesting point revealed in the present case study is that it was cold air from the Ukrainian High and not from the Siberian High which was of significance in this weather development over northwest India.

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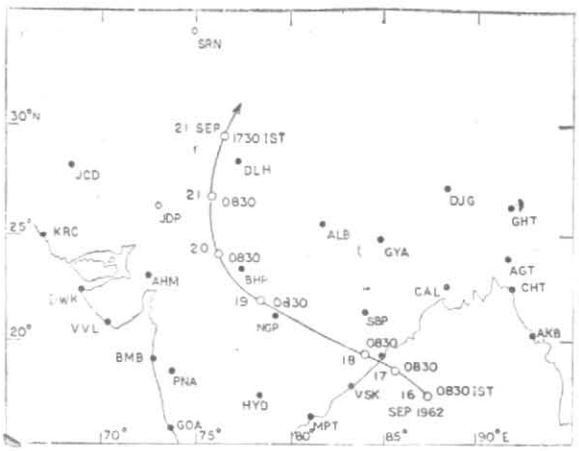

Fig. 1. Track of monsoon depression during the period 16—21 September 1962

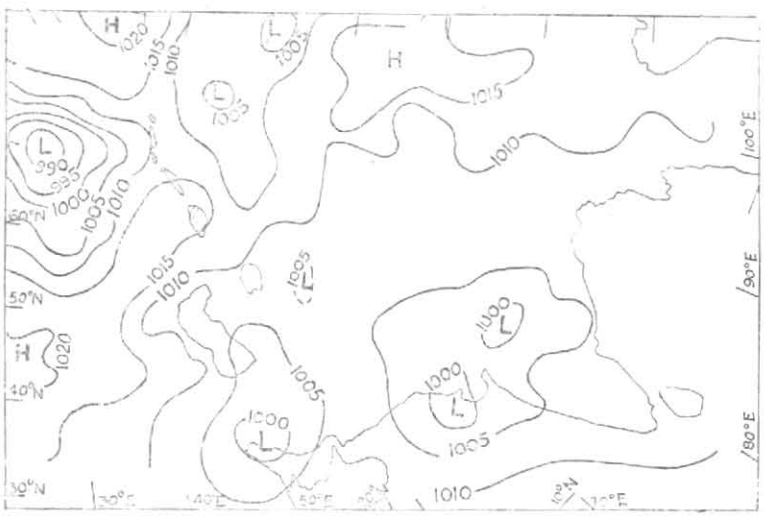

Fig. 2. Sea level chart on 00 GMT of 12 September 1962

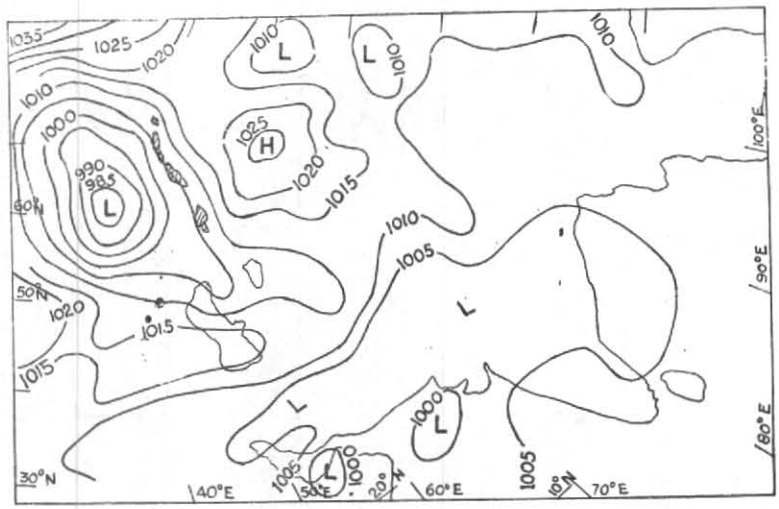

Fig. 3. Sea level chart of 00 GMT on 14 September 1962

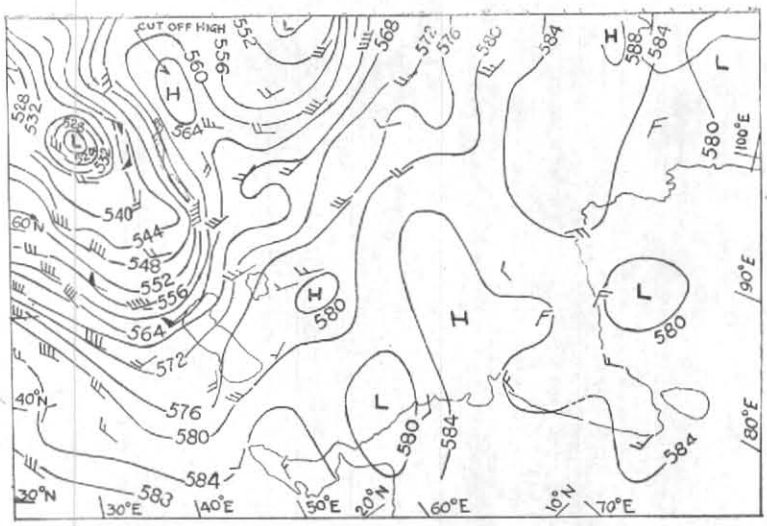

Fig. 4. Flow pattern at 500 mb in tens of gpm on 16 September 1962

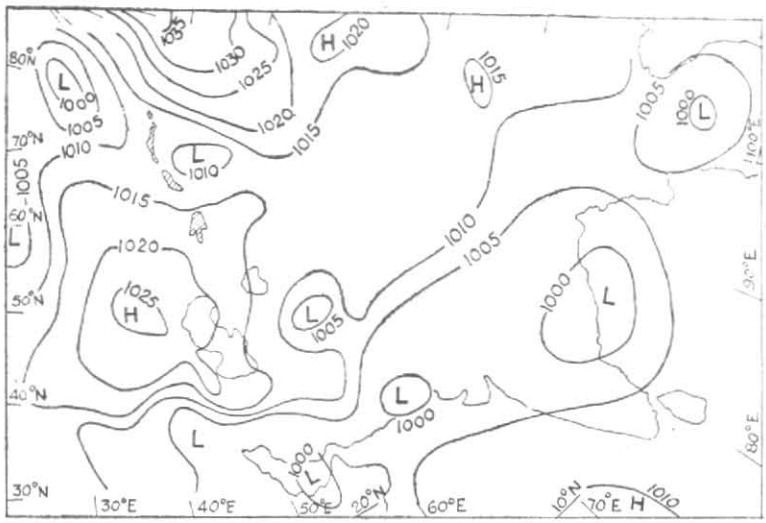

Fig. 5. Sea level chart of 00 GMT on 17 September 1962

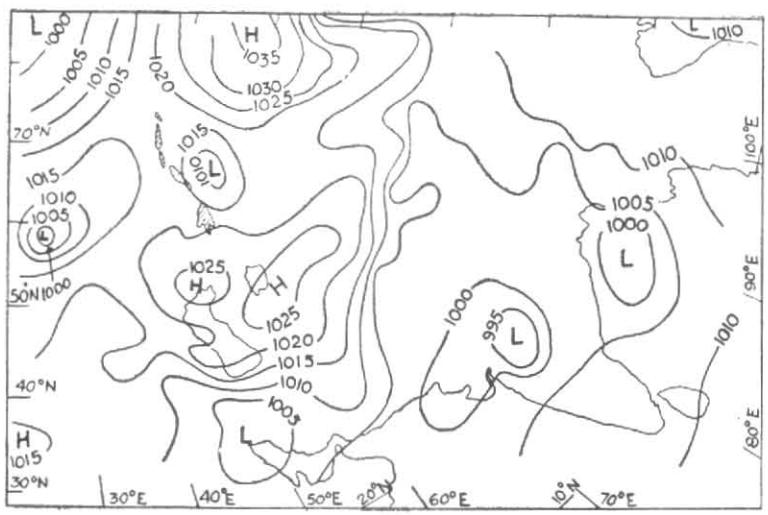

Fig. 6. Sea level chart of 00 GMT on 20 September 1962

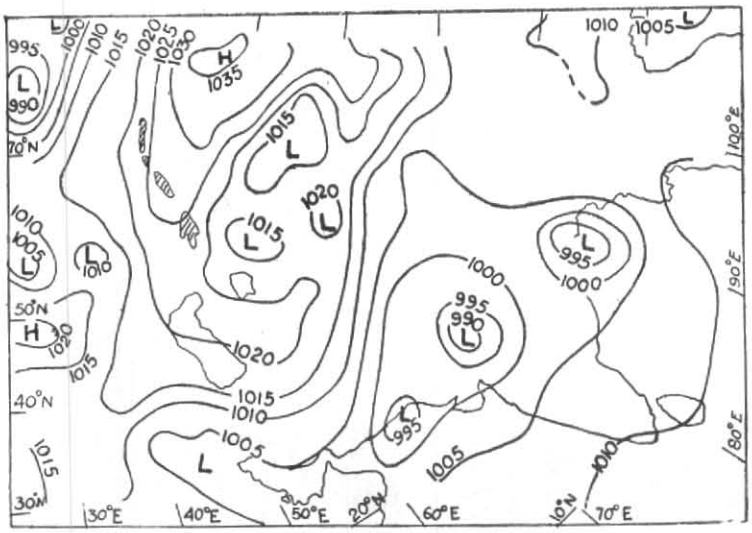

Fig. 7. Sea level chart of 00 GMT on 21 September 1962

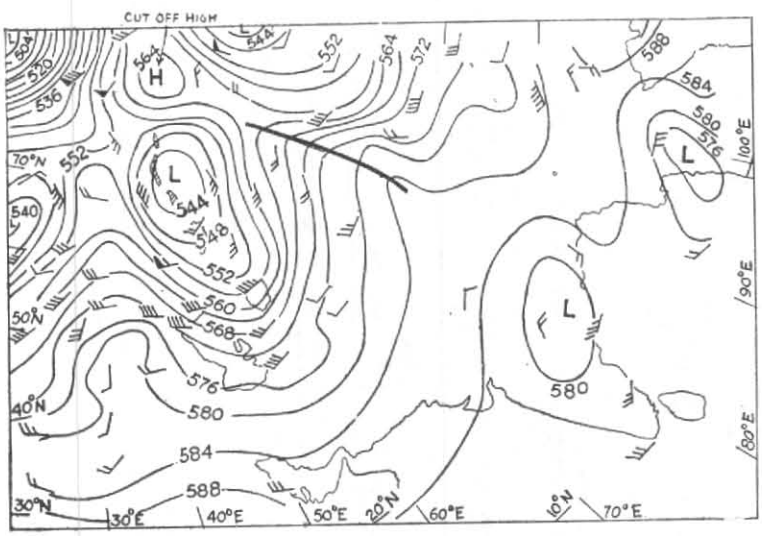

Fig. 8. Flow pattern at 500 mb in tens of gpm on 18 September 1962

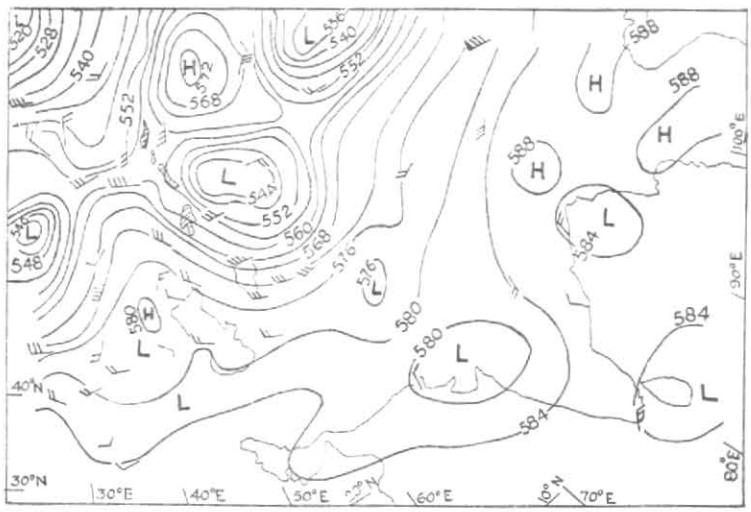

Fig. 9. Flow pattern at 500 mb in tens of gpm on 20 September 1962

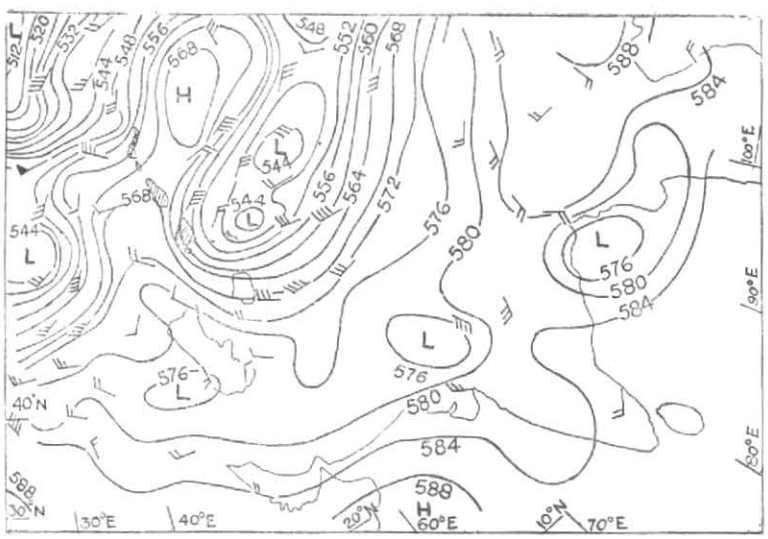

Fig. 10. Flow pattern at 500 mb in tens of gpm on 21 September 1962