551.509.53(544.6)

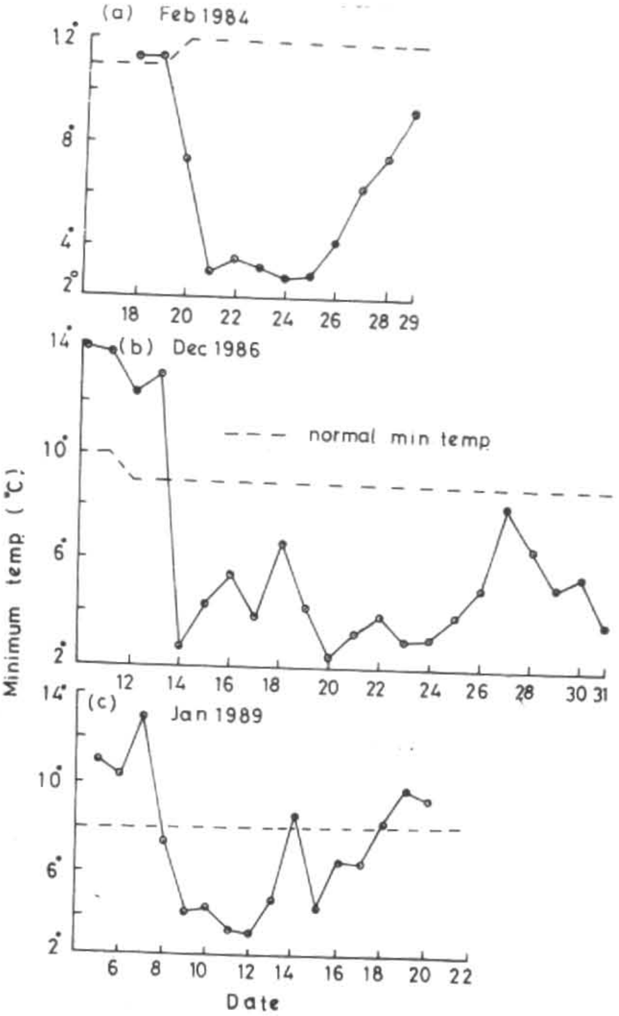
FORECASTING OF MINIMUM TEMPERATURE AT JAIPUR AND SOUTH RAJASTHAN

1. Low temperature coupled with strong surface winds are hazardous for both mankind and vegetation. When minimum temperature falls below 4° C, frost occurs, which affects vegetation and crops. Hence, prediction of minimum temperature and occurrence of cold wave is necessary. Manral (1978) showed that there is a close relationship between the lower level winds and change of minimum and maximum temperature at Bombay Airport. Raghavan (1967), Subbaramayya and Suryanaryana Rao (1976) studied the occurrence of heat and cold wave that prevailed over the Indian subcontinent, in detail.

In this paper authors have attempted to study the probable cause of sudden fall of 5° C or more in minimum temperature thereby causing cold wave condition (min. temp. below 5° C from normal) over Jaipur and south Rajasthan.

2. *Data*—Daily minimum temperature data of Jaipur observatory and rest Rajasthan State for the last 10 winter seasons (1981-89) alongwith the upper wind data upto 3.1 km a.s.1. of Jaipur have been utilised. 1200 UTC upper wind data of Jaisalmer, Barmer, Jodhpur, Bikaner, Ganganagar and Udaipur (JSM, BRM, JDP, BKN, GGN and UDP) have also been utilised.

3. *Analysis and discussion*—Rajasthan State gets winter rain with the passage of Western Disturbances (WD) which move from west to east in the northern



Figs. 1 (a-c). Variation of daily minimum temperature recorded at Jaipur observatory

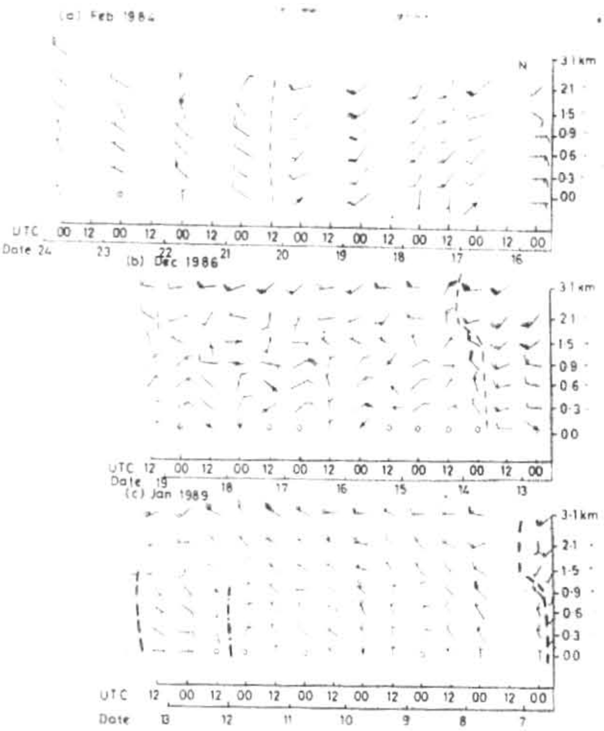


Fig. 2. Variation of lower level winds recorded at Jaipur observatory

latitudes of the country. The secondary of WD sometimes penetrates as far south as 22°N (Singh and Agnihotri 1977). These WD sometimes induce low pressure area over central Pakistan and adjoining Rajasthan areas and thereby cause duststorm, winter rain, dust haze and cold spells which sometimes become very severe and widespread covering up to south Rajasthan and Gujarat area.

3.1. Temperature of a place generally depends on (*i*) net solar radiation received from sun, (*ii*) advection of cold/warm airmass, (*iii*) local effects such as nature of soil, orography and topography of that place. The first factor is mainly due to apparent motion of the sun. In the northern hemispheric winter season, the advection is caused by lower level winds. These winds transport warm moist/cold dry air mass to the station. Along with the advection other factors like nature of soil, topography, orography play a vital role in lowering minimum temperature.

Nature of soil is important and its effect specially over Rajasthan State cannot be ruled out because the loose sand soil has lower specific heat and high albedo than that of clay soil, which enhances radiative cooling.

During the period (1981-89) of this study there were three significant long spells of severe cold wave over Jaipur and adjoining areas, which continued for 4 to 8 days. These were :

(a) 20-28 Feb 1984
(b) 13-25 Dec 1986
and (c) 09-13 Jan 1989.

3.2. Table 1 give the number of occasions when min. temp. fell (a) by 5° C or more during past 24 hrs, (b) below 5° C or less from the normal respectively. This table reveals that :

(*i*) On an average total number of cases of fall in temp. by 5° C or more are equally distributed in the months of Dec, Jan and Feb.

(*ii*) Number of occasions when cold wave conditions are noticed is more in the month of Feb as compared to Dec and Jan.

3.3. Figs. 1 (a-c) shows sudden fall of min. temp. and its departure from the normal in the case of Jaipur. These drops in min. temp. are well supported by the wind plotted in the vertical time section (VTS). Fig. 2. clearly indicates that if the extension of the northerly flow is up to higher altitudes (3.1 km), and cold wave

TABLE 1

Frequency table for variation of min. temp at Jaipur

Year	No. of occasions when min. temp. fall≥5°C during past 24 hr				No. of occasions when min. temp. below 5°C or less from normal			
	Dec	Jan	Feb	Total	Dec	Jan	Feb	Total
1980-81	—	—	2	2	—	—	1	1
1981-82	2	—	2	4	—	—	1	1
1982-83	1	—	—	1	—	1	4	5
1983-84	1	1	1	3	2	3	11	16
1984-85	1	1	—	2	1	—	5	6
1985-86	1	2	—	3	—	4	1	5
1986-87	1	2	—	3	11	1	—	12
1987-88	1	—	1	2	3	—	—	3
1988-89	1	1	2	4	1	4	4	9
Total	9	7	8	24	18	13	27	58

TABLE 2

Wind direction and speed (mps) at stations west of Jaipur (1200 UTC)

Date	Min. temp. JPR	Winds at 0.9 km JPR	JSM	BRM	BKR	GGN
06 Jan 89	10	21006	32512	16501	26504	06001
07 Jan 89	13	—	02004	02002	32505	31503
08 Jan 89	07	31506	01005	33002	36003	28003
04 Feb 89	10	28006	25007	24506	26508	22003
05 Feb 89	16	27014	28011	26511	28508	30007
06 Feb 89	09	25005	29002	27009	25007	24001
25 Feb 88	09	32004	20002	26001	27003	32002
26 Feb 88	13	16503	23012	—	21511	11505
17 Jan 87	13	34505	36004	04006	00504	35005
18 Jan 87	06	34504	03502	03004	01503	35507

advection takes place, then the drop in temp. is quite severe [Fig. 1(b) : fall of 10.4° C in min. temp. on 13-14 Dec 1986].

The study of synoptic situation for above three spells reveals that WD is moving across northern latitudes of country; formation and movement of cyclonic circulation in lower tropospheric levels over central Pakistan and west Rajasthan. As such the northerly component of winds at stations west of Jaipur might give some definite indication regarding fall of temp. at Jaipur at least 12 hours in advance. Table 2 gives variation of minimum temperature recorded at Jaipur and winds at 0.9 km a.s.l. at different stations west of Jaipur on some occasions to illustrate this point. The magnitude of drop in min. temp. is associated with the strength of westerly system. The immediate approach of another system WD once cooling has taken place may not give further rise in temperature and cold spell is likely to continue.

3.4. While considering the entire state, it has been noticed that the lower min. temp. is attained in south Rajasthan (Udaipur division) than in the north. Due to latitudinal difference in solar heating there is cold and dry air mass over the northern parts of Rajasthan (Jaipur) whereas to the south, it is comparatively warm and moist in the months of winter season. In the north-west Rajasthan the lower level wind flow is from NNW and it changes to NNE while reaching the southern parts of the State due to seasonal anticyclonic circulation. The lowest temp. attained in south Rajasthan is due to cold advection supported by radiative cooling of loose sand dunes, *i.e.*, of low specific heat as compared to compact and hard clay. The other factor is topography of south Rajasthan. Due to stagnation of NE winds in the windward side of Aravali hills, Udaipur division indicates more cooling as compared to north Rajasthan.

The fall in temp. takes place on synoptic scale, *i.e.*, once the fall starts from NW Rajasthan, this wave front moves ahead in SE'ly direction and thus covering the whole state. The fall in temp. in south Rajasthan (Udaipur div.) occurs after a lag of one day and with wind from NNE direction.

3.5. Secondly, the top soil of Rajasthan is mainly constitute of loose sand which has quite low moisture content in its vicinity. Less vegetation and quite low humidity in the atmosphere are also favourable factors for severe fall of temp. after radiative cooling at night. The min. temp. in Kota division are slightly higher than those Udaipur division which may be due to more polluted industrial smoke.

4. *Conclusion* — Backing of 00 UTC wind at Jaipur station invites colder air from northern latitude and veering is accompanied by warmer air from southern latitude. The quick response of loose sand and presence of quite low moisture content in ambient air, while radiative cooling further cools down the cold wind coming from the northerly latitude. The temp. fall is due to increase in northerly component with greater vertical extent of pronounced strength. Paucity of vegetation further enhance the cooling effect.

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