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Forecasting of severe convective activity over Lucknow in pre-monsoon months

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सार — प्रस्तुत शोधपत्र में लखनऊ में सन् 1985 से 1988 तक, मार्च से मई महीनों के बीच 00 तथा 12 ग्रीनविच मानक समय रेडियोसोंदे आरोह से स्थिरता सूचकांक, औसत सापेक्षिक आर्द्रता तथा 03 ग्रीनविच मानक समय समकालीन प्रेक्षणों से ओसांक की भूमिका का परीक्षण किया गया। अध्ययन से ज्ञात हुआ कि स्थिरता सूचकांक –4 या उस से कम, औसत सापेक्षिक आर्द्रता 45% या इस से अधिक तथा ओसांक सामान्य से अधिक की स्थितियां गरज के साथ तूफान आने के लिए अनुकूल होती हैं। मध्य तथा उपरि क्षोभमण्डलीय पछुवाओं में वृहत् आयामी द्रोणिका 70° पूर्व के आसपास प्रभावी पाई गई।

ABSTRACT. In this paper the role of stability index (SI), mean relative humidity (MRH) from 00 and 12 GMT radiosonde ascents and dewpoint from 03 GMT synoptic observations of Lucknow for the period March to May 1985-88 has been examined. The study reveals the SI value—4 or less, MRH 45% and above with dew point above normal are favourable for thunderstorm occurrence. Presence of large amplitude troughs in mid and upper tropospheric westerlies prove effective when these are around 70 °E.

1. Introduction

Showalter (1953) developed an objective method for forecasting of thunderstorm by the use of "Stability Index" derived from local radiosonde data. Tripathi (1956) and Joseph (1957) applied this method for the forecasting of thunderstorms over Poona and Madras respectively. Basu (1961) and Seshadri (1961) applied this method based on two radiosonde ascents a day (00 and 12 UTC) for forecasting of thunderstorms over Delhi.

We have examined the role of Showalter's "Stability Index", Mean Relative Humidity (MRH) at standard pressure levels between 850 hPa and 500 hPa and surface dewpoint values for forecasting of thunderstorm activity over Lucknow during March to May (1985-88).

2. Data and methodology

Surface dewpoint departures from normal for 03 UTC observations were taken into computations.

Mean relative humidity (MRH) at standard pressure levels between 850 and 500 hPa at Lucknow was computed with the help of T-ϕ gram of Lucknow.

Stability Index (SI) is computed through the difference between the observed 500 hPa temperature, and the temperature an air parcel at 850 hPa would acquire, if it were lifted dry adiabatically to lifting condensation level (LCL) and then pseudo-adiabatically to 500 hPa.

The stability indices for each day for both 00 and 12 UTC radiosonde ascents of Lucknow were computed for the same period.

Fig. 1 represents the SI against MRH on the thunderstorm days for March to May 1988. The occurrence had been confined only to a region with SI —4 or less and MRH 45 per cent or more, out of a total of 15 occasions of thunderstorm, 10 occurrences had been in this region.

In majority of cases it was found that the SI value which is positive or slight negative at 00 UTC became more negative at 12 UTC on the same day (Fig. 2). Under changing atmospheric conditions, thus, there is a need of utilising both the 00 and 12 UTC radiosonde ascents.

3. Discussion

The mean percentage occurrence of thunderstorm as shown in Fig. 1 in the preferred region for thunderstorm is 56. Table 1 reveals that when SI —4 or less, MRH 45 per cent or more and dewpoint above normal the average percentage occurrence was 81.2 and Table 2 shows that 40% of these (or 33.3% of total cases) are accompanied with squall. The SI and MRH used in Tables 1 & 2 correspond to 00 UTC ascents.

It is noticed that even when SI value is negative there had been no thunderstorm occurrence, when the MRH was less than 45. When SI is +4 or more there has been no thunderstorm irrespective of high MRH value and dewpoint temperature.

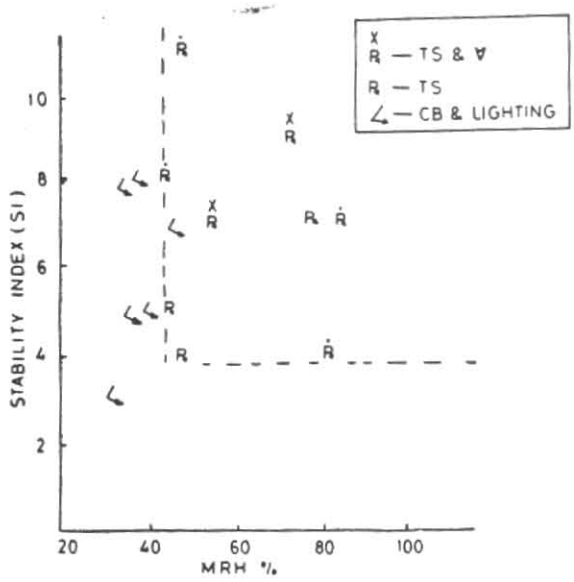

Fig. 1. Profile of thunderstorm activity with SI/ MRH for Lucknow (March-May 1988, 00 UTC ascent)

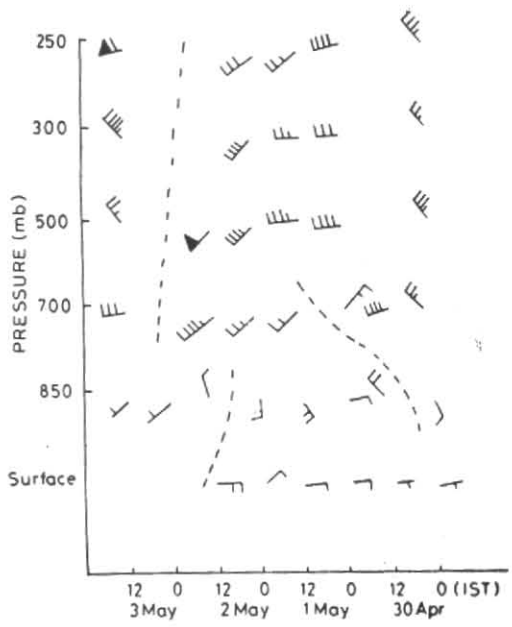

Fig. 2. Vertical time-section over Lucknow (30 Apr to 3 May 1987)

TABLE 1

S. I.	MRH (%)	Dew-point	No. of occa-sions	No. & per-centage of TS occur-rence
—4 or less	45 or more	AN	48	39 (81.2)
Do.	Do.	N	26	1(4)
Do.	Do.	BN	30	0(0)
—4 or more	45 or less	AN	0	0(0)
Do.	Do.	N	15	0(0)
Do.	Do.	BN	37	0(0)

Note : SI and MRH correspond to 00 UTC ascents

TABLE 2

S.I.	MRH (%)	Dew-point	No. of occa-sions	No. & per-centage of TS with squall occurrence
—4 or less	45 or more	AN	48	16 (33.3)
Do.	Do.	N/BN	56	0 (0)
—4 or more	45 or less	AN/N/ BN	52	0 (0)

Note : SI and MRH correspond to 00 UTC ascents

Table 1 further reveals that out of 26 occasions when SI value —4 or less with MRH value 45% or more and dewpoint temperature normal, the number of occurrence of thunderstorm is 1 only which is 4%. Out of 30 occasions when SI value —4 or less with MRH value 45% or more and dewpoint temperature below normal, the number of occurrence of thunderstorm is zero.

It may also be seen from Table 1 that out of 52 occasions when SI value has been —4 or more with MRH value 45% or less, the number of occurrence of thunderstorm is zero, irrespective of dewpoint temperature.

Table 2 reveals that the thunderstorms with squall have occurred only when the SI value was —4 or less, MRH value 45% or more and dewpoint temperature above normal. The number of occurrence of thunderstorm accompanied by squall was 16 which is 33.3%.

Table 3 shows the frequency distribution of time interval between the occurrence of thunderstorm and radiosonde ascents for 00 and 12 UTC. It is seen from this table that the occurrence of thunderstorm had been 90% between 4 & 12 hours after the 00 UTC, while in the case of 12 UTC ascent the occurrence had been 75% within 9 hours after the observation. SI is usually more negative for 12 UTC ascents as compared to the 00 UTC ascent of the same day. MRH and SI value at 00 UTC ascent has better prediction value.

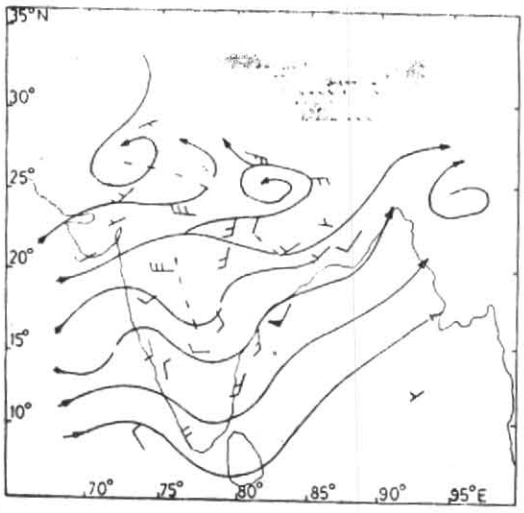

Fig. 3. Upper air chart at 0.9 km at 00 UTC of 2 May 1987

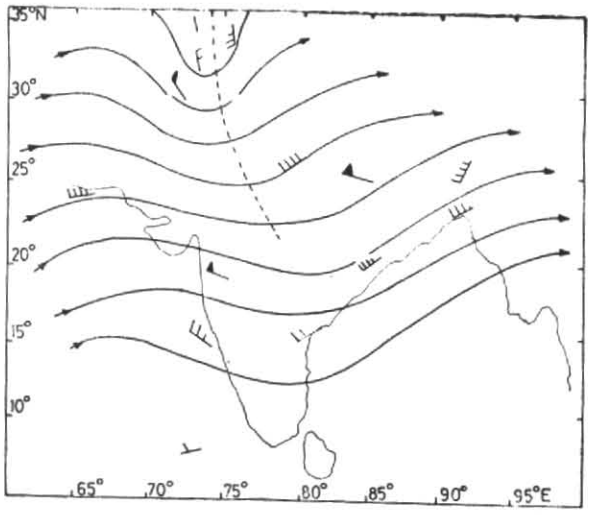

Fig. 4. Upper air chart at 300 hPa of 2 May 1987

TABLE 3

Time of obsn. (UTC)	Time of occurrence after the corresponding observation				Total No. of TS occurrence
	1-3 hr	4-6 hr	7-9 hr	10-12 hr	
00	2 (10%)	3 (15%)	8 (40%)	7 (35%)	20
12	4 (20%)	6 (30%)	5 (25%)	5 (25%)	20

3.1. *Detailed examination of few thunderstorm situation accompanied with squalls*

Srinivasan (1961) has examined some such situations of thunderstorms for western India in pre-monsoon months. A few of specific synoptic situations are discussed here.

(*i*) On 13 May 1986 a widespread thunderstorm accompanied with squalls occurred in U.P. Lucknow recorded a maximum wind speed 84 kmph during the westerly squall. According to newspapers, many trees were uprooted and electric and telecommunication disrupted.

A western disturbance lay over Haryana and northeast Rajasthan as an upper air system on 12th and persisted there on 13th. It became unimportant over hills of west Uttar Pradesh and Himachal Pradesh on 14th.

An upper air cyclonic circulation lay over east Uttar Pradesh on 12th and persisted there till 14th. It lay over Bihar State and adjoining areas on 15th.

SI value on 13th at 00 UTC was —6, MRH value 52% and surface dewpoint temperature was above normal at Lucknow.

(*ii*) On 2 May 1987 widespread thunderstorms accompanied with squalls occurred in Lucknow (U.P.), recorded a maximum wind speed 130 kmph during the westerly squall. According to local newspapers, Lucknow reported death of 4 persons in a wall collapse in Krishana Nagar locality, and in cantonment area, about 200 trees uprooted and many cement corrugated roof of the buildings were completely ripped off.

In the upper air there was a well marked eastward moving trough in westerlies at 300 hPa as seen between Lat. 30° N-10° N and Long. 76° E on 2 May in Fig. 4. A low level cyclonic circulation existed extending up to 0.9 km a.s.l. over central parts of U.P. The middle & upper tropospheric trough in the westerlies passed around 3rd at 00 UTC as seen from the vertical time section of Lucknow in Fig. 2. On 2 May 1987 in 00 UTC radiosonde ascent the value of stability index was —8 and MRH value 60% and surface dewpoint temperature was above normal at Lucknow. Thus, the widespread thunderstorms occurred over U. P. ahead of this upper tropospheric trough which is the zone of advection of maximum positive vorticity as shown by Anderson *et al.* (1974) through application of satellite imagery.

(*iii*) On 18 May 1988 a widespread thunderstorm accompanied with squalls occurred in Lucknow (U. P.), recorded maximum wind speed 130 kmph during the northerly squall. According to local newspapers, trees were uprooted and telecommunication and electricity totally paralysed.

A WD lay over Punjab and adjoining areas as an upper air system in the evening of 17 May and it persisted there till 18 May.

SI value on 18 May was —11.5 at 1200 UTC and MRH value was 54% and also dewpoint temperature was above normal.

4. Conclusion

The frequency distribution of time interval between the occurrence of thunderstorm and the ascents for 00 UTC and 12 UTC gives a clue for day-to-day work in thunderstorm forecasting of Lucknow. On occasion whenever SI value —4 or less with MRH value 45% or higher and dewpoint temperature above normal conditions are evidenced in either the 00 UTC or 12 UTC radiosonde ascents, thunderstorm can be reasonably expected to occur between 4 & 12 hours after the ascent in the case of 00 UTC radiosonde ascent and within 9 hours after 12 UTC ascent.

The occasions with SI value —4 or less, MRH 45% or more, alongwith surface dewpoint temperature above normal are favourable for the occurrence of thunderstorm

Severe thunderstorm activity with squalls over Lucknow may occur in association with the approach of large amplitude troughs in the mid and upper tropospheric westerlies along 70° to 75° E longitude over northwest India.

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