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A Stability Index for Thunderstorm Forecasting over Delhi

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Showalter (1953) developed an objective method for forecasting of thunderstorms by the use of "Stability Index" derived from local radiosonde data. Tripathi (1956) and Joseph (1957) tried to investigate the application of this method in the forecasting of thunderstorms over Poona and Madras respectively and found the method to be reasonably useful. Their findings were based on one radiosonde ascent a day, *viz.*, that of 1500 GMT, and the same was correlated with the occurrence or otherwise of thunderstorm during the next 24 hours. The changes in the upper air temperature and humidity conditions within the next 24-hour period and prior to the occurrence or otherwise of thunderstorm had obviously to be ignored in those studies. Since then two radiosonde ascents daily at 00 and 12 GMT have been introduced at a number of stations in India, and in this note an attempt has been made to find out by utilising data of two radiosonde ascents a day, as to what extent Showalter's "Stability Index" method could be applied with success in the forecasting of thunderstorm over Delhi during the premonsoon months (April, May and June).

Stability index for Delhi (Safdarjung) has been calculated from the tephigrams for 00 and 12 GMT for each day during the months April, May and June for five years from 1955 to 1959 excepting for 26 occasions out of a total of 455 days, when the radiosonde ascents were either not available or did not reach 500-mb level.

The occurrence of squalls, duststorms, thunderstorms and development of cumulonimbus clouds with observed lightning (or thunder heard) over Delhi during the period April, May and June of the years 1955-59 were noted down from the monthly meteorological registers and current weather registers of Safdarjung and Palam against the respective dates. The number of occasions when stability index had different values $\leqslant -4$ to $\geqslant 4$ have been shown in the second row of Table 1. The number of occasions when thunderstorms, duststorms, squalls, lightning etc occurred during the next 12 hours have been shown in the next row under corresponding values of the stability index. Percentage occurrence of such phenomenon following different stability index are shown in the fourth row of the table. The number of occasions when these duststorms or thunderstorms were accompanied with squalls are shown in the last row of the table.

It will be seen from Table 1 that during the 12-hour period subsequent to the time of stability index, thunderstorms etc occurred on 44 out of 53 occasions with negative index values being 4 or higher, *i.e.*, on 83 per cent cases. Similarly, percentage occurrence of thunderstorms etc with indices —3, —2, —1 and 0 were 76, 62, 57 and 42 per cent respectively indicating progressively lesser percentage of occurrence with lesser negative value of index. On the other hand percentage occurrence of

TABLE 1

	Stability Index								
	—4 or more negative	—3	—2	—1	0	1	2	3	4 or more
No. of occasions	53	34	34	14	24	23	67	41	139
No. of thunderstorms etc	44	26	21	8	10	3	12	4	6
Percentage	83	76	62	57	42	13	18	10	4
No. of occasions with squalls	20	8	7	3	1	1	3	2	2

TABLE 2

	Stability Index								
	—4 or more negative	—3	—2	—1	0	1	2	3	4 or more
No. of occasions	38	40	32	22	25	26	68	41	132
No. of thunderstorms	31	25	19	13	14	4	14	7	7
Percentage	82	65	65	63	56	16	20	17	5

TABLE 3

	Stability Index								
	—4 or more negative	—3	—2	—1	0	1	2	3	4 or more
No. of occasions	50	33	28	18	44	25	35	39	113
No. of thunderstorms	32	14	15	4	15	6	11	6	20
Percentage	64	42	54	22	34	24	31	15	17

thunderstorms etc corresponding to positive indices 1, 2, 3 and 4 or more were appreciably low being 13, 18, 10 and 4 per cent respectively. It is noteworthy that of as many as 139 occasions with index value +4 or more, only 6 cases were associated with thunderstorms etc.

It is seen from the table that when the value of negative stability index increased from 0 to 4 or more percentage cases of thunderstorms etc also increased from 42 to 83 and when the positive stability index increased from 0 to 4 or more, percentage cases of thunderstorms etc decreased from 42 to 4 only.

It will further be seen from the table that out of 44 cases of thunderstorms corresponding to index value —4 or more negative, 20 cases, that is about 45 per cent cases, were accompanied with squalls. Similar percentages of squalls corresponding to indices having values —3 and —2 were somewhat less and those corresponding to positive indices were still lower. It would thus appear that probability of a thunderstorm being accompanied with squall is greater with higher negative values of the stability index, as one would normally expect.

The number and the percentage occasions of thunderstorms etc that occurred during the next 24 hours corresponding to the different values of stability index from —4 or more negative to 4 or more have also been calculated for 00 GMT ascent and shown in Table 2. The same for 1200 GMT ascent is shown in Table 3.

In case of stability index calculated from 00 GMT ascent (Table 2) it will be seen that during the 24 hours subsequent to 00 GMT there is a progressive increase in the percentage cases of thunderstorms from 56 to 82 as the value of negative index increased from 0 to 4 or more, whereas with the increase of positive index from 0 to 4 or more, the percentage decreased from 56 to 5 only. While in case of stability index calculated from 12 GMT ascent (Table 3) with the increase of negative value of index from 0 to 4 or more, though there was a general increase of percentage cases of thunderstorm (during next 24 hours subsequent to 1200 GMT) and general decrease in the percentage cases with the increase of positive indices from 0 to 4 or more, but the results obtained are rather erratic. This is so because quite a good number of duststorms or thunderstorms either preceded the time of observation or occurred at the time of observation. Thus 00 GMT ascent is comparatively more useful than 12 GMT ascent for the assessment of thunderstorm probability over Delhi.

The number of cases of thunderstorms that occurred between 1400 and 1600 GMT were studied separately with respect to values of indices calculated from 00 and 12 GMT ascents respectively. In majority of cases it was found that the stability index value, though positive or low negative at 0000 GMT, became higher negative at 1200 GMT of the same day. Moreover, from the computed results of the indices between 850-mb and 500-mb levels, it has been seen that, in quite a good number of cases there is a large variation in the index value of 12 GMT from that of 00 GMT of the same day, which justifies the necessity of utilisation of two radiosonde ascents for this purpose.

In addition to the computation of indices between 850-mb and 500-mb level, attempt was also made to find out the correlation with indices for a lower slab, *viz.*, between 900-mb and 800-mb levels, but it was found that in most cases the saturation of 900-mb level parcel, lifted adiabatically and took place at a level above 700 mb and hence 500 mb was found to be more appropriate.

The correlation with the indices for the slab between 900 mb and 500 mb were also examined and it was found that the results obtained were almost similar to those obtained by the correlation of indices between 850 mb and 500 mb.

The occasions with negative stability indices of value 4 or more not accompanied with thunderstorms were also studied with respect to the synoptic situations. In most of the cases, synoptically, the situations were found to be unfavourable for the development of thunderstorms. On two occasions only the synoptic charts were somewhat favourable for the development of thunderstorms, but the cases ended with the development of cumulonimbus clouds only. In each of these two cases it was seen from the upper wind charts that Delhi was on the ridge of anticyclone in the lower levels. This is probably the reason for thunderstorm not developing on both the occasions.

Thus inspite of the limitations, the stability index method, though not a perfect forecast too, is a simple and highly significant factor. A negative index indicates instability and a positive index indicates stability condition. In short, the stability index offers a simple and easily understood method for making a quick check on the possibilities of thunderstorms etc. This method would be of much help along with the synoptic charts in the forecasting of local thunderstorm.

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