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PRACTICAL ASPECTS OF THE CONVECTIVE TURBULENCE THEORY OF THUNDERSTORMS

Ramalingam (1960) in his convective turbulence theory of thunderstorms, has derived a critical condition according to which a breakdown in the atmosphere should occur if the term $(\log P_1/P_0) / (\log \theta_0/\theta_1)$ exceeds 19, where P_1 and P_0 are the pressures at some higher level and the ground level respectively and θ_1 and θ_0 are the potential temperatures corresponding to the dry bulb temperatures at these levels. A brief study of the thunderstorms that were experienced at some of the stations in northern India during the premonsoon period of the year 1960 has been made with reference to the critical value of the Index, as suggested therein.

For this purpose the value of the Index for the stations New Delhi, Amritsar, Allahabad and Jodhpur for the months March to June has been calculated from the 00 GMT radiosonde ascents. The extent of the instability which a particular atmosphere is capable of developing on a hot afternoon depends, among other factors, on the maximum temperature reached on that particular day. Therefore in calculating the value of the Index, θ_0 has been taken as the potential temperature corresponding to the actual maximum temperature attained. P_1 and θ_1 refer to the pressure at 500 mb and the potential temperature at the same level. The value of the 500 mb temperature assumed to have remained unaltered since morning ascent.

From the values of the calculated Indices a graph (Fig. 1) has been drawn which gives the value of the Index fairly accurately for the range of potential temperatures between 280° to 340°A, without making any calculations. For finding out the value of the Index on any particular day, the difference of potential temperatures

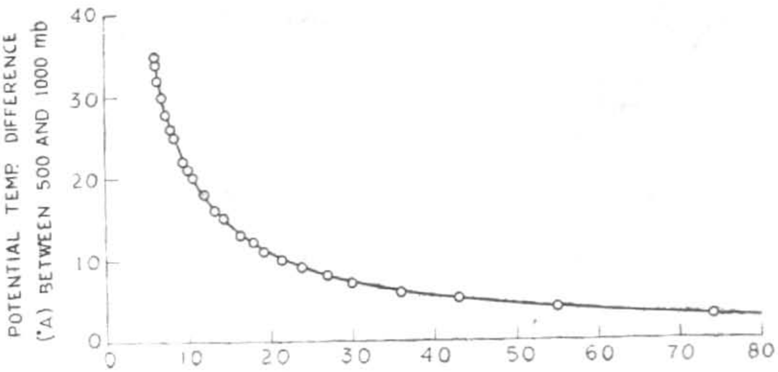

FIG. 1.

TABLE 1

Number of days when the Index was greater than 19

Month	New Delhi	Amritsar	Allahabad	Jodhpur
March	13	11*	11	12
April	26	19	20	21
May	21	12†	11	21
June	15	No data	7	7
Total	75	42	49	61

*Data available for 16 days only

† Data available for 20 days only

TABLE 2

	Index greater than or equal to 19: No. of cases when actual thunderstorm or thundery conditions developed at the station within next 24 hours					Index greater than or equal to 19: No. of cases when no thundery conditions developed within next 24 hours					Index less than 19: No. of cases when actual thunderstorm or thundery conditions developed at the station within next 24 hours				
	Mar	Apr	May	Jun	Total	Mar	Apr	May	Jun	Total	Mar	Apr	May	Jun	Total
New Delhi	5	7	7	7	26	8	19	14	8	49	5	1	0	4	10
Amritsar	2	3	2	..	7	9	16	10	..	35	1	2	1	..	4
Allahabad	3	4	3	2	12	8	16	8	5	37	3	0	5	3	11
Jodhpur	3	5	3	3	14	9	16	18	4	47	0	0	1	8	9
Total					59					168					34

between the 1000-mb and 500-mb levels should be found out from the tephigram and then the value of the Index can be readily obtained against this difference. It is seen from the graph that the critical condition is expected when the difference of potential temperatures in degrees absolute between these levels is 11 or less.

The results obtained are summarised in Tables 1 and 2. Table 1 gives the number of days on which the value of the Index was greater than or equal to 19. Table 2 gives the distribution of weather phenomena which occurred on days when the Index was greater than 19.

It will be seen from Table 1 that on approximately 59 per cent of the days in the premonsoon months the value of the Index exceeded the critical value. The analysis of the occurrence of thunderstorms as shown in Table 2 points out that only on approximately 26 per cent of the days on which the Index exceeded 19, either thundery conditions or actual thunderstorms occurred. Another fact which is brought out is the occurrence of thunderstorms on days on which the Index was less than 19 (37 per cent of the total number of thundery days). However a large number of these storms were in association with phenomena, other than of local origin, such as the movement of active western disturbances over the areas concerned.

It has not been possible to study the cases of clear air turbulence due to lack of available data on the subject.

It may thus be concluded that the theory in its present state fails to predict the occurrence of thunderstorms in a large number of cases. This may be due to the following reasons—

(1) Various assumptions made while deriving the critical conditions for the upturning in the atmosphere may not be entirely valid when applied to large scale instability phenomena like thunderstorms.

(2) It has been assumed that the 500 mb temperature remains unaltered except in cases where the air mass has appreciably changed since the previous sounding. But this is not borne out by actual radiosonde soundings. It is seen that approximately on 40 per cent of the days the difference in temperatures at 500-mb level between the morning and the evening ascents is more than 4°C. It is not known how many of these differences are due to instrumental errors. However, in cases where changes of air mass have really occurred upto the 500 mb, the values of the Index based on the morning tephigrams would not be appropriate to the afternoon conditions.

(3) According to Ramalingam (1960) the moisture seems to play apparently a minor part so far as the initiation of the thunderstorms is concerned. It is, however, felt that along with the critical number, if due consideration is given to the humidity in the lower levels, the theory might yield positive results in a greater number of cases.

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REFERENCE

Ramalingam, N. 1960 *Nature*, **185**, pp. 900-901.