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USE OF LATENT INSTABILITY, SHOWN ON A T-ϕ GRAM, AS A CRITERION FOR FORECASTING THUNDERSTORM AT A STATION

Following the enunciation by Normand, in the early thirties of the present century of a simple geometrical method of estimating latent instability in the atmosphere on the basis of a T-ϕ gram of a station, several papers were published by meteorologists in India giving the results of their study of a number of past thunderstorms or squall-type duststorms, which showed that these were almost invariably the outcome of latent instability, of the 'real' type. These investigations held out a very good promise for forecasts being made out readily and with confidence about the incidence or otherwise of these relatively short-lived and yet violent local storms, provided the aerological data for the station were available in time for issue of such forecasts. The inauguration of the radio method of sounding of the upper atmosphere was, therefore, looked forward to most keenly by meteorologists in India as also others in tropical countries. Now that radiosonde ascents at a number of stations, especially at places where the main forecasting offices are situated have been made in India for 5 years and more, it would be of interest to review how far these data have been found helpful in forecasting these local storms, on consideration of latent instability ; as shown on the latest T-ϕ gram.

With a view to examining the position in this regard, the T-ϕ grams of Calcutta for the three months March to May, 1949 have been examined. The season was one of unusual thunderstorm activity in West Bengal and neighbourhood, and as many as 24 thunderstorms, accompanied by squall, passed over Calcutta during this period. The examination of the T-ϕ grams has shown that, except on three days when appreciable latent instability of the real type was indicated on the T-ϕ gram and on four other occasions when the atmosphere had only limited latent instability realisable at heights of 2·5 km. and above, little or no latent instability was shown by T-ϕ grams based on ascents at 0830 hrs. I. S. T., even when due allowance was made for the rise in dry and wet bulb temperatures in the afternoon as a result of insolation. It is thus apparent that if the forecast of development of thunderstorm at the station was restricted to only such days when the T-ϕ gram showed latent instability, the failures would have been too many. The question that, therefore, arises is what happened on these days in the interval between the time of radio sonde ascent in the morning and that of actual occurrence of the weather in the afternoon or evening which altered the thermodynamical structure of the atmospheric column over the station from its original stable state to one of instability. The study of the surface synoptic charts and also the stream lines of upper winds at various heights hardly supports the view of any large scale change of the atmospheric structure as a result of a new airmass having arrived over the area under consideration. The factors which bring about the modifications in the structure appear therefore to be of a more local character, and may not therefore be indicated always by soundings made 6 to 12 hours earlier.

It is well-known that the majority of nor'westers which affect Calcutta do not develop locally but occur in continuation of a chain of thunderstorms which usually start at a point, some two to three hundred miles away to the northwest or north of Calcutta, in South Bihar or north Chota Nagpur and occasionally in north Bengal. The results of investigations which are being carried out by the writer show that the thunderstorm vortex originates at some discrete point close to the line of discontinuity between the continental air from northwest to west and the pseudomaritime air from some southerly direction, and it then rolls down the discontinuity in an anti-clockwise sense. The question as to how the thermal or thermodynamical structure of the air column over a station gets modified as a result of the approach of a thunderstorm vortex from a neighbouring region therefore merits consideration for the understanding of the mechanism of the eventual development of thunderstorm over the place. The importance of the squall head, moving in from a neighbouring thunderstorm field in providing the necessary trigger to help the release of the energy of latent instability in the atmosphere over a place has been well recognised in India but, in addition, there is also the

question as to how far the temperatures or lapse rate conditions in the upper air get modified as a result of divergence aloft of air over a neighbouring thunderstorm field, or of the spreading of the Cb tops which at times leads to the sky being rapidly covered with As clouds shortly before the thunderstorm strikes the station. Considering that the development of instability in the atmosphere should be a necessary pre-requisite for the release of the very considerable energy associated with a thundersquall, a local and temporary modification of the atmospheric structure by a process as suggested above appears to provide the only satisfactory answer to the problem under consideration.

From what has been stated above, it is obvious that the non-existence of latent instability in the atmosphere, as shown by radiosonde ascent, 6 to 12 hours earlier, cannot always be taken as a safe criterion for not forecasting the incidence of a thundersquall at a station, unless the instability phenomenon is to develop locally. Considering that in the large majority of cases in the nor'wester season the chain of thunderstorm squalls which eventually affect Calcutta starts at a point somewhere in south Bihar or north Chota Nagpur, the provision of special radiosonde ascents in this season at a suitable station in that locality might be of considerable value in connection with nor'wester warnings.

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