Letters To The Editor

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ON THE ROLE OF UPPER LEVEL ADVECTION OF COLD AIR IN THE DEVELOPMENT OF DUSTSTORMS AND THUNDERSTORMS OVER DELHI

In recent years several workers (*see references*) have discussed the significance of upper level cold pools in the development of thunderstorms. Ramaswamy and Bose (1953, 1954) have studied the subject in regard to the nor'westers which occur over Northeast India and Eastern Pakistan in the pre-monsoon season, and have drawn attention to the importance of mid and upper troposphere thermal troughs and lows in the outbreak of these thunderstorms. They have also stated, in a general way, that cold troughs and cold pools move across Northwest India and Western Pakistan and influence weather over these regions. In relation to their study of the thunderstorm activity over Northeast India and Eastern Pakistan, they have particularly emphasized the importance of the advection of cold air (in the layer 700—500mb), associated with the thermal systems, in the development of such weather. The object of this note is to study, statistically, the part played by the upper level advection of cold air in the development of duststorms and thunderstorms over Delhi.

For the purpose of this study, the available radiosonde temperature data of 8 years (1945-52) in respect of occasions when well-developed thunderstorms and duststorms, accompanied with squalls, passed over Delhi, have been examined. In order to see whether any significant advection of cold air had taken place in the layer 700—500 mb, either on the day of squall or on the previous day, the latest upper air temperatures at 700, 650, 600, 550 and 500-mb levels, prior to the passage of the squall, were compared with those available from an earlier ascent on the squall day, if any, and also with temperatures obtaining on the previous day and the day before that. In cases when no radiosonde ascent was available on the day of the squall and prior to its occurrence, the upper air temperatures on the previous day were compared with those prevailing two days before the squall.

The percentage frequencies of the total number of occasions when a change (rise or fall) of 3°C or more (*i.e.*, 5°F or more) occurred at one or more of the above-mentioned levels (with little or no change at other levels) in the layer 700—500 mb, prior to the occurrence of the duststorms or thunderstorms, are given in Table 1. A change of less than 3°C has been taken as insignificant for the purpose of this study.

TABLE 1

Period	Fall of more than 3°C	Rise of more than 3°C	Insignificant change	Total No. of occasions
Jan-Feb	37	13	50	8
Mar-Jun	29	21	50	90
Jul-Sep	20	13	67	30
Oct	50	15	35	6
Nov-Dec	—	—	—	1

The percentage frequencies corresponding to a fall of 5°C more (9°F or more) are shown below—

Jan-Feb	Mar-Jun	Jul-Sep	Oct
25	14	13	33

It will be seen from the above that the number of occasions when a fall of temperatures occurred in the layer 700—500 mb is much smaller than the number of occasions when temperatures either rose or remained practically stationary. During the pre-monsoon season, March-June, when more than 75 per cent of the squall type thunderstorms and duststorms occur, a fall of 3°C or more occurred on 29 per cent of the occasions and a fall of 5°C or more, only on 14 per cent of the occasions. It may also be mentioned in this connection that the mean upper air temperatures at the standard levels

on the days of squall (taken within 24 hours prior to the occurrence of squalls) in any month, were almost the same as the mean normal temperatures for that month. It would, therefore, appear that the advection of cold air at the upper levels is not a very important pre-requisite for the development of thunderstorm activity over Delhi, as on more than 70 per cent of the occasions there was little or no change of temperatures or even a rise of temperatures in the layer 700—500 mb. It may be mentioned in this connection that there were occasions when upper air temperatures fell a day before the occurrence of thunderstorms or duststorms but on the actual day of the storm and prior to its occurrence were found to be almost the same or even higher, in some cases, than those prevailing two days before the storm, showing that the cold air which had come on the previous day was not present on the day when the storm occurred. It may also be stated that the squalls accompanying the duststorms and thunderstorms prior to which significant advection of cold air occurred were, generally, not severer. Apparently, processes other than advection of cold air at the upper levels, are responsible to a greater degree in the development of duststorms and thunderstorms over Delhi. Since Delhi can be taken to be representative of Northwest India from the point of view of weather, the above inference may be applicable for the whole of Northwest India.

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