

Movements of two Nor'westers of West Bengal : A Radar study

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ABSTRACT. Two of the worst nor'westers of the year 1955 have been analysed by using observations from a 3-cm meteorological radar installed in the Meteorological Office at Dum Dum Airport.

1. Introduction

The movement of nor'westers of West Bengal, especially those affecting Calcutta have been considered, directly or indirectly, by some Indian workers (Chatterjee and Sur 1938, Desai and Mull 1938, Desai 1950 and Rao and Boothalingam 1957). It has been felt in India, as anywhere else in the world, that the thunderstorms not associated with any well-marked frontal activity are too localised to afford analysis with the help of the usual synoptic charts and as such, the installation at Dum Dum in 1954 of a meteorological radar working in the 3-cm band was hailed as a very welcome feature particularly by those who are interested in the analysis of the character and movement of thunderstorms especially nor'westers. In this paper it is intended to report the radar observations of two nor'westers of April 1955, which incidentally were the two most violent ones of the year and might be identified as non-frontal squall-lines discussed by the Thunderstorm Project.

2. Method and scope of the observations

A Decca meteorological radar type 41, working on a wave length of 3-cm and employing a PPI was used. The radar was worked for 10 minutes in every hour as a matter of routine for keeping watch on any thunderstorm development detectable within the maximum range of 250 miles. As soon as some echoes were received, frequency of

observations were suitably increased and significant echoes leading to nor'westers passing over and near the station were closely studied. On account of this fact the observations during the very initial stages of the activities under review could not be taken. The absence of RHI rendered any study of the cloud build-up impossible. Pending the availability of further facilities with regard to radar observations in some future date, an analysis of the broad facts as could be made with the existing radar is presented in the following sections indicating in particular the bearing of the observations on the movement of these two worst nor'westers of the year 1955.

3. Description of the echo patterns

On 3 April 1955, the radar pictures (Figs. 1 and 2) at 1630 and 1642 IST indicate a patch of activity over the station which was in fact giving light rain with thunder preceded by a mild southwesterly gust at 1650 IST. This activity in itself, being very mild, is not of much interest for our present analysis. The feature that proved to be interesting by subsequent developments can be seen in the radar picture at 1642 that lies about 27 miles to the northwest of the station. In the next picture obtained at 1700 IST (Fig. 3) this patch has gained in length extending from 310° *, 25 miles† to 010° , 22 miles. In the subsequent phase (Fig. 4), the above

*Bearing of the echo in degrees from north

†Radial distance of the echo from the centre of the scope

patch has developed further to form a line and at 1733 IST (Fig. 5) the line is longer and nearer the station lying through the points 270° , 20 mi; 310° , 22 mi; 360° , 18 mi and 040° , 40 mi. The line is also fairly 'solid' in nature—a term used here to mean the compactness of the array of *Cb* cells as opposed to individual *Cb* cells arranged in a line but as much separated from one another as not to produce a continuous line pattern echo—and has got an average width of 6-8 miles. After this observation had been taken the radar unfortunately failed, the magnetron having become "gassy" and so the later radar history of the line could not be obtained. The other meteorological observations relating to this nor'wester was, however, recorded in detail; a north-westerly squall of 44 mph struck the station at 1806 IST and had the characteristic fluctuations of pressure, temperature and humidity associated with it.

The set of observations obtained on 8 April 1955 started with a special radar observation at 1545 IST (Fig. 6) that revealed a patch of activity rather intense around a point (330° , 70 mi) with a feeble line extending from 010° , 75 mi to 080° , 100 mi. Over and above these, some scattered cells could also be seen around a point (005° , 60 mi). Referring to Fig. 7 obtained at 1605 IST it may be noted that these scattered cells have merged with the main cell which is now a well-developed solid-looking line-formation extending between 315° , 60 mi and 030° , 45 mi. The same condition practically persisted till 1618 IST. At 1700 IST (Fig. 8) the line is indicative of severe activity or at least of large liquid water content and predominance of large drops in all the cells forming the line, now within 15 miles of the station, accompanied by development of a fresh cell on the west. In another 25 minutes the line having bent* and looking like a hook, can be seen to have encircled the station (Fig. 9) on the north, the southern arm of the bifurcated eastern half of the line affecting the station, as if encircling it from the northeast. It was apparently this branch of the line that gave a

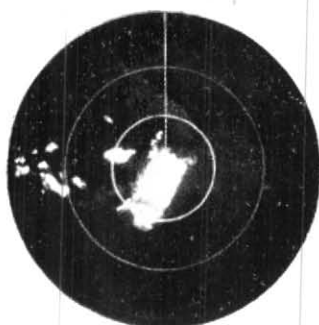
north/northeasterly squall in another few minutes. The main line passed over the station about quarter of an hour later giving the most violent squall of the season—a north/northeasterly squall of 82 mph. With the second squall came a spell of heavy rain over the station blocking all radar observations beyond a few miles, so that an analysis of the squall-line as it passed over Dum Dum was not possible. After rain had become sufficiently light radar observations were followed up which showed at 1845 IST (Fig. 10) that the activity had decayed to a great extent.

4. Analysis of observations

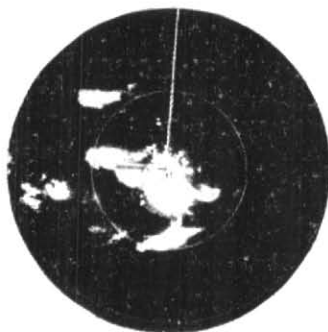
Looking at the observations against the wind field aloft above 10,000 ft a.s.l. (Figs. 11 and 12) we find on 3 April 1955 that under conditions of drift of a cell in the west-south-westerlies we should expect a west-south-westerly movement which should consequently give a west-south-westerly squall. As a matter of fact the small patch of activity over the station at 1630 IST had its initial growth to the southwest of the station and was at the time of observation moving away very slowly eastwards. The wind at 2000 and 5000 ft a.s.l. on the other hand do not offer any clue with regard to influence of mean wind on this movement as the line of thunderstorms lie more or less in the field of wind shear. The squall-line moved, however, from a direction of 340° at a speed of 23 knots which is obtained by considering the situation at 1718 IST and the fact that the squall struck the station at 1805 IST. In computing this speed of movement, it has been assumed that the line formation observed at 1733 IST has moved down a normal to the line passing through Dum Dum (observing station). This explains a north-north-westerly squall at Dum Dum, on the assumption that the downdraft from a line formation will be most effective in a direction normal to the line itself.

An interesting point to note about the observations of 3 April is the preference for the direction in which the line elongated

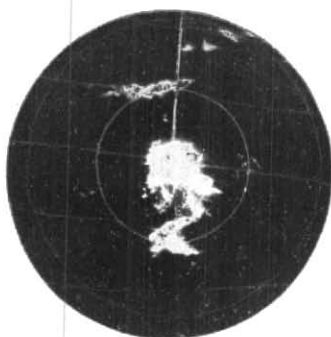
*Cf. Tepper, M. (1950). *Monthly Weather Review*, 78, p. 117



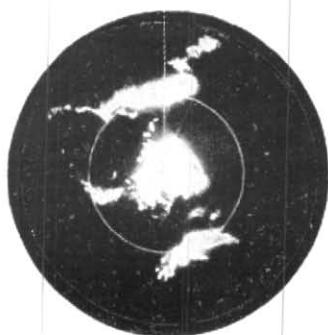
1630 Fig. 1 20



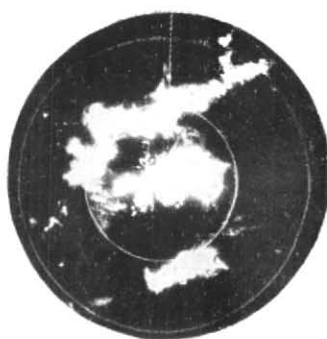
1642 Fig. 2 20



1700 Fig. 3 20



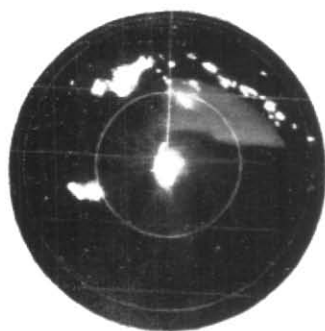
1718 Fig. 4 20



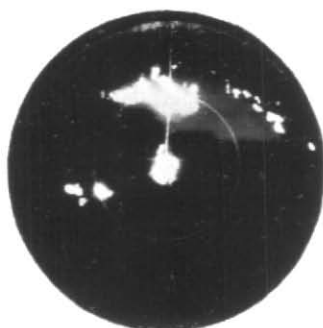
1733 Fig. 5 20

Figs. 1-5. PPI presentations of storm detecting radar at Dum Dum Forecasting Office on 3 April 1955

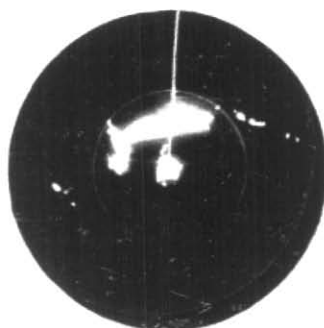
(Figures in the left and right bottom corners indicate time in IST and range rings in miles respectively. The vertical line represents true North)



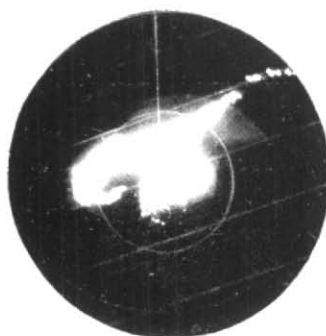
1545 Fig. 6 50



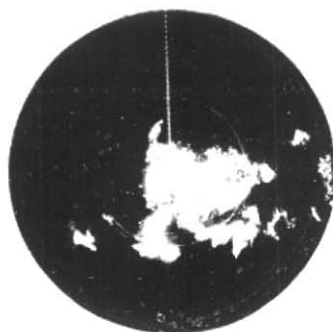
1605 Fig. 7 50



1700 Fig. 8 50



1725 Fig. 9 20



1845 Fig. 10 20

Figs. 6-10. PPI presentations of storm detecting radar at Dum Dum Forecasting Office on 8 April 1955
 (Figures in the left and right bottom corners indicate time in IST and range rings in miles respectively. The vertical line represents true North)

and became more compact. The elongation might be caused by individual independent formation of cells on the low level shear line (Fig. 12) or by sidewise downdrafts from a parent cell which subsequently formed new cells only on the shear line. There is, however, no observation in support of either possibility.

From the observations of 8 April 1955, it is seen that the movement of the squall line from north to south is decisive, the average speed of movement being about 33

knots, but for reasons not understood by the present authors the line, just before striking Dum Dum, branched out. This branching and bending were apparently responsible for a north/northeasterly squall rather than a pure northerly squall as would be anticipated from the general movement of the line. It will be clear even on a casual examination that neither the lower level winds nor those at higher levels (Figs. 13 and 14) can explain in terms of pure drift, the southward movement of the line at an average speed of 33 knots.

REFERENCES

Chatterjee, G. and Sur, N. K.	1938	<i>Mem. India met. Dep.</i> , 26, 9, p. 165.
Desai, B. N.	1950	<i>Indian J. met. Geophys.</i> , 1, 1, p. 74.
Desai, B. N. and Mull, S.	1938	<i>Gerl. Beitr. Geophys.</i> , 53, p. 285.
Rao, D. V. and Boothalingam, P. N.	1957	<i>Indian J. Met. Geophys.</i> , 8, 1, p. 61.

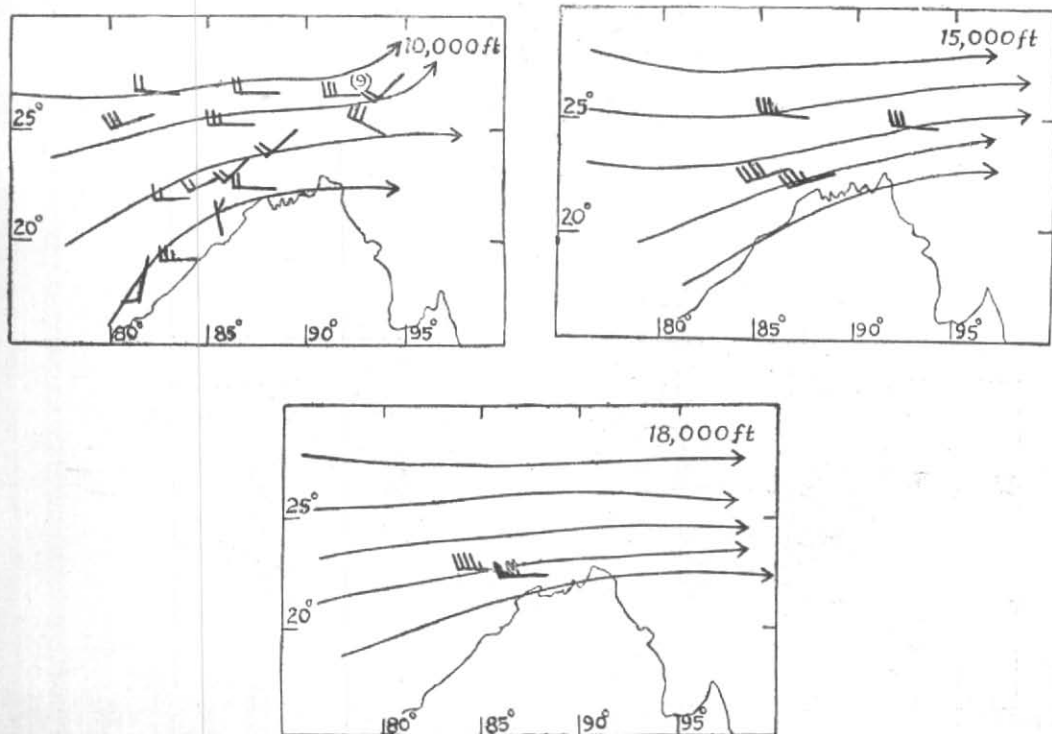


Fig. 11. Upper wind charts at 0730 IST of 3 April 1955 at 10,000, 15,000 and 18,000 ft

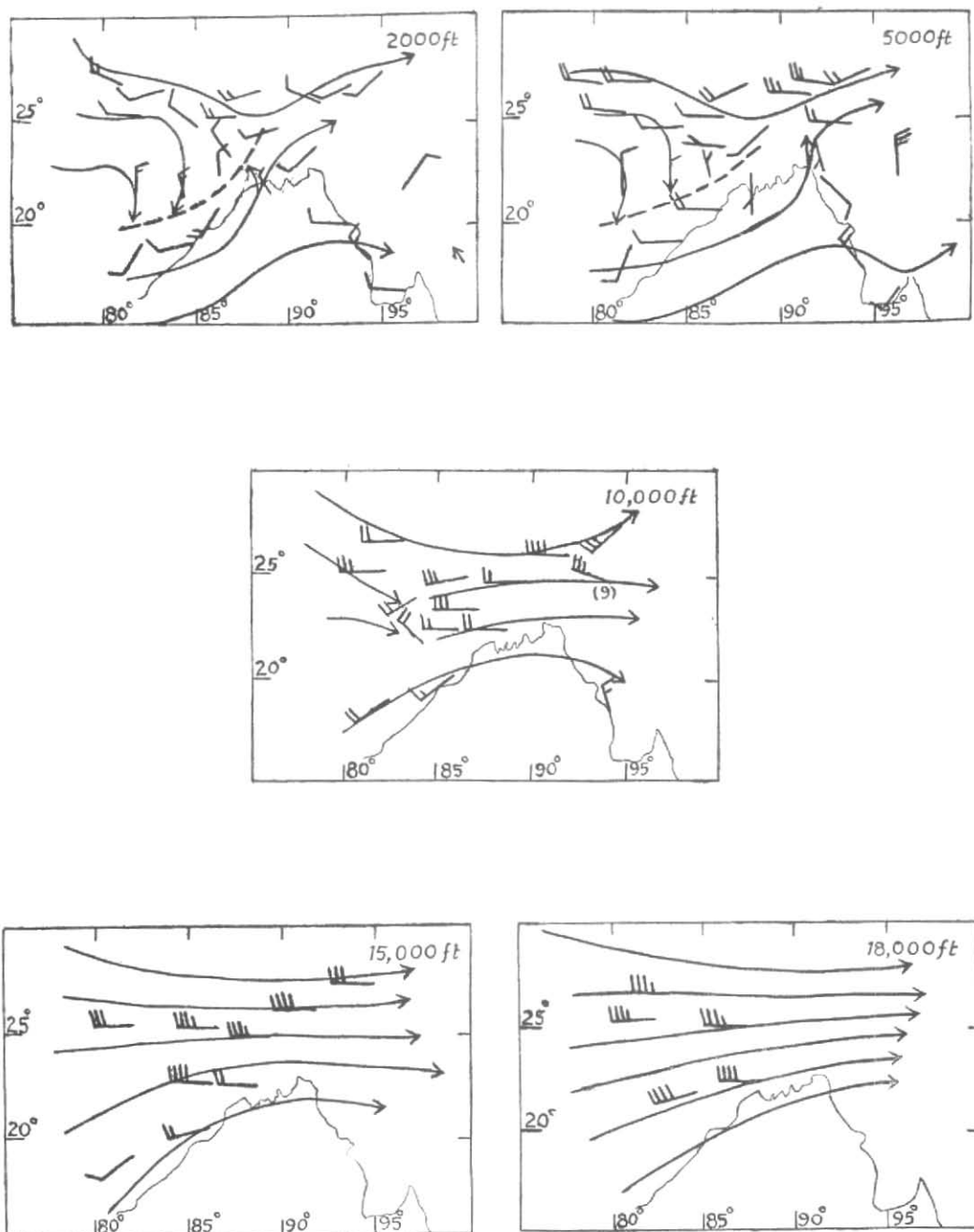


Fig. 12. Upper wind charts at 1430 IST of 3 April 1955 at 2000, 5000, 10,000, 15,000 and 18,000 ft
(The wind discontinuity is shown by broken lines)

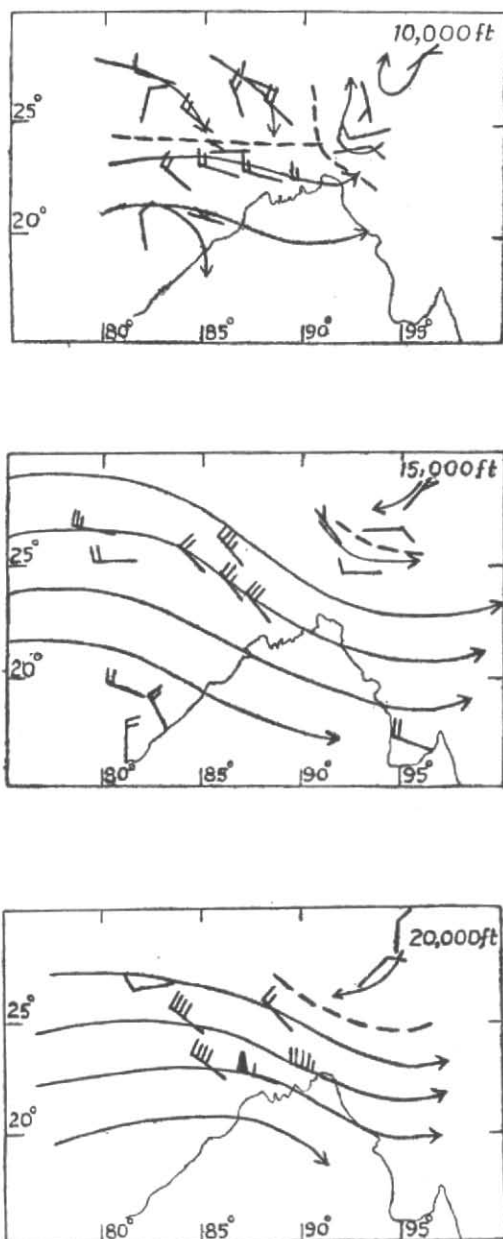


Fig. 13. Upper wind charts at 0730 IST of 8 April 1955
at 10,000, 15,000 and 20,000 ft
(The wind discontinuity is shown by broken lines)

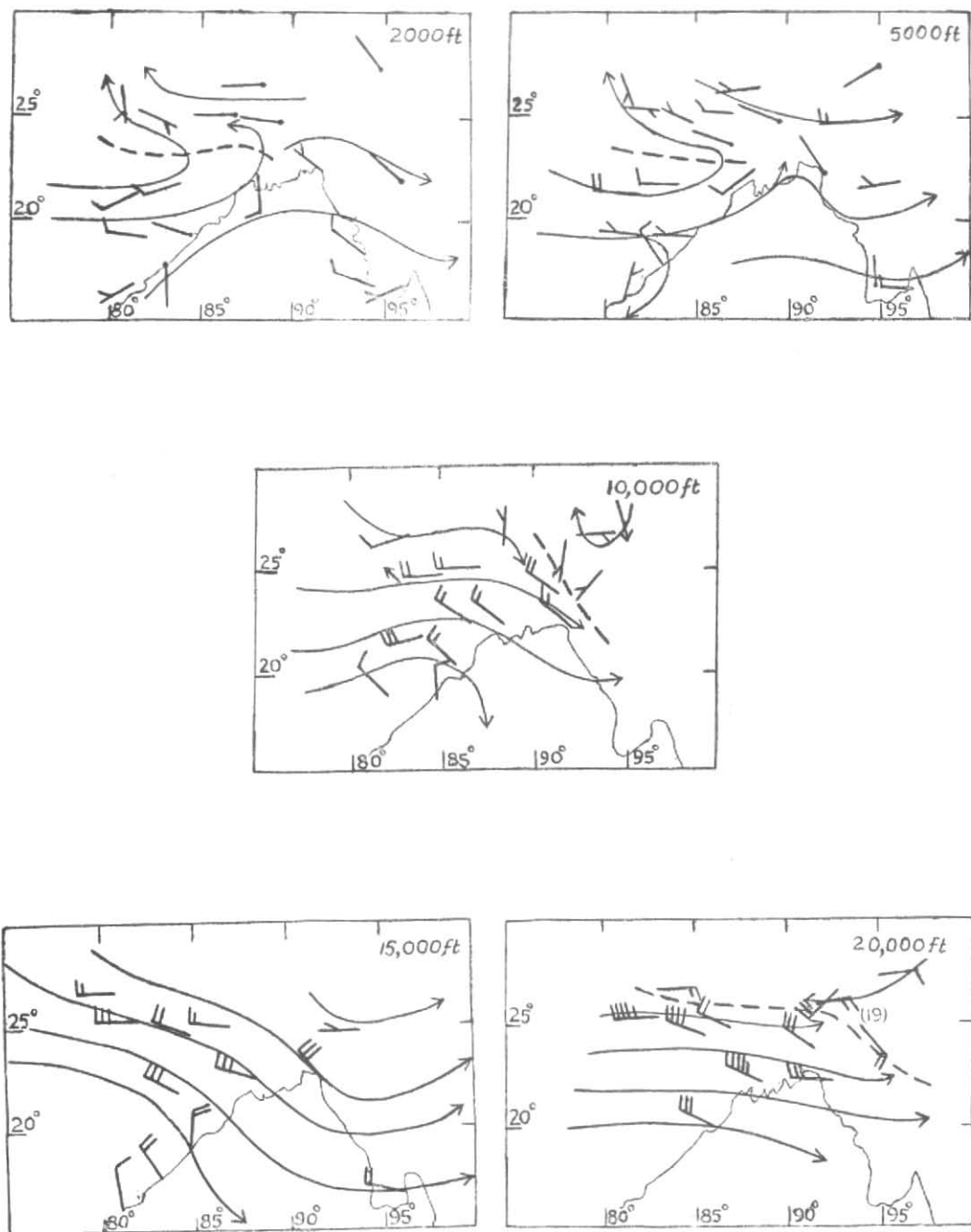


Fig. 14. Upper wind charts at 1430 IST of 8 April 1955 at 2000, 5000, 10,000, 15,000 and 20,000 ft

(The wind discontinuity is shown by broken lines)