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## RADAR MEASUREMENTS OF UPPER WINDS OVER POONA DURING THE SOUTHWEST MONSOON

The India Meteorological Department was able to obtain for their use a number of radars, type A.A. No. 3, Mk. III. These radars operate on a frequency of 204 mc/s (105 cm) and have a peak power output of 90 KW. One of the instruments was put into regular use at Poona from June 1949 for determining upper winds. Except for the information available from pilot balloon observations in clear spells, no observations of upper winds above the cloud level are available so far during the monsoon months June to September; the present paper summarises the upper winds above the cloud level, up to a height of nearly 10 km during the two monsoon periods in 1949 and 1950.

A number of types of targets were tried for use with the radar. The dipole target was the simplest and gave good results. To obtain best results, the length of the dipole target is reduced by about 5 per cent of the half wave length of the radar. In practice "tuning" is not very sharp and small variations in length will not result in decreasing the efficiency. There can also be deviations from straightness; with a radar which is horizontally polarised, the dipole

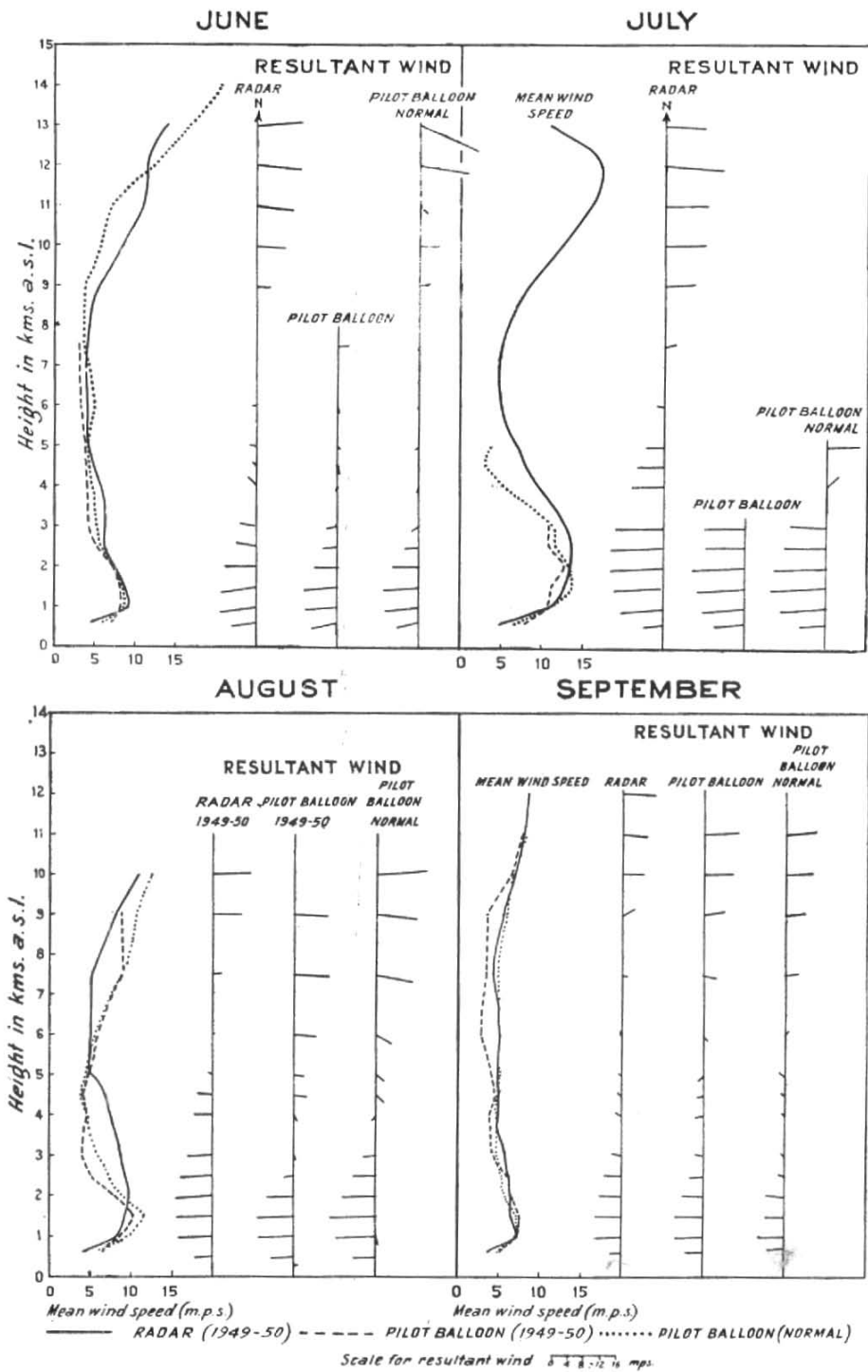


Fig. 1

### E-W COMPONENTS

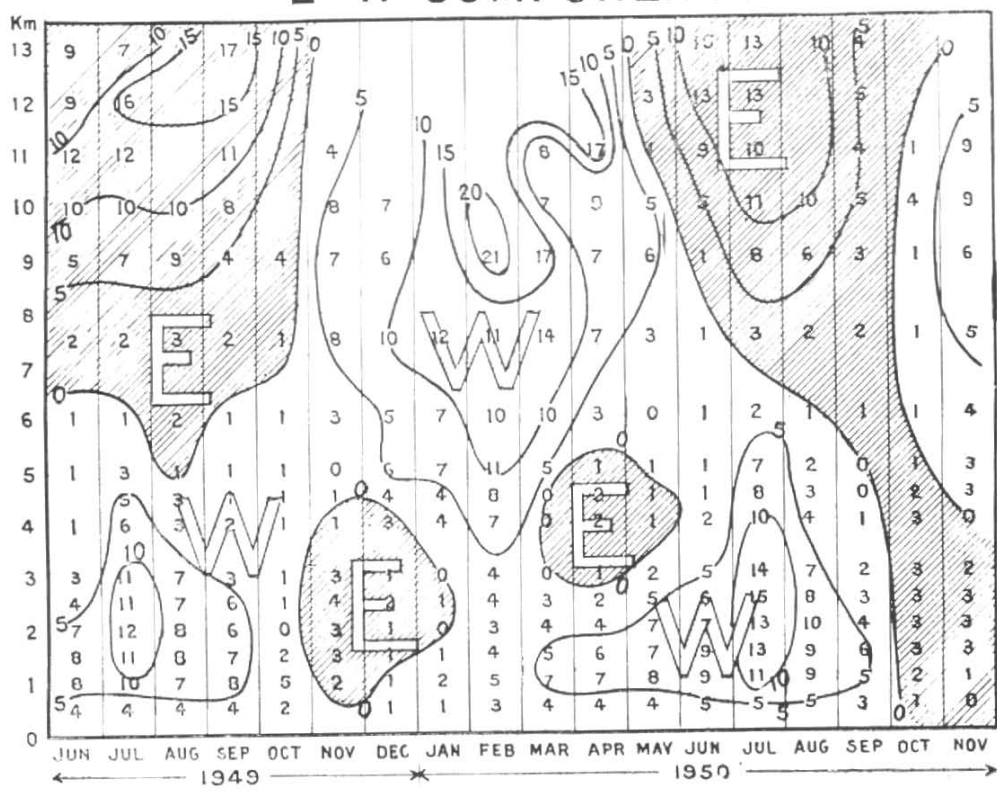


FIG. 2

should be flown horizontally and for vertically polarised sets, vertically. In order to obtain good response on all bearings, three dipoles were flown fixed at right-angles to each other. Three pieces of bare copper wire, 18 SWG, and 27.5 inches were used and fixed in a light bamboo frame. With this type of target, which weighs only about 150 gm a smaller balloon will meet the requirements. Due to the lightness of the target, it is possible to increase the free lift of the balloon to keep the target at fairly high elevation angles when the winds are strong and in the same direction in the lower levels of the atmosphere. This will avoid the "clutter effect" on the radar which appears when the target is at low angles at great distances and facilitates the chances of obtaining wind information for higher levels than is otherwise possible.

When radar observations were first started in June 1949 at Poona the target was attached to the radiosonde balloon released at 1400 GMT and the rate of ascent was about 20 kmph. But during these monsoon months, the winds in the lower levels at Poona up to a height of nearly 6 km are from the west and blow at approximately 30 kmph in some levels. The balloons were, therefore, found to drift to low angles before they had reached any appreciable height and the echoes used to get lost in the ground clutter. To obtain upper wind information to greater heights, the rate of ascent of the balloon had to be increased to nearly 30 kmph. The high rate of ascent, however, could not be employed with the radio-meteorographs, and therefore, from 14 July 1949 separate balloons were used to carry the targets only. The balloons generally used weighed about 350 gm and were given a free lift of 2000 gm. They were let off at 0900 GMT.

However, after the monsoon months were over, and the skies were clear, the radar flights in the afternoon (0900 GMT) were discontinued and the target was attached to the radio-meteorograph let off after the sunset and followed as long as possible (from 1 October 1949 and from 4 November 1950).

The relative number of observations at various levels in the afternoon made with pilot balloon during the height of the monsoon (July-August) during a period

of 12 years (1937—49) and the number with the radar for two years (1949—50) for the same months are given below —

Heights a.s.l. (km)	Pilot Balloon (12 years)	Radar (2 years)
1	786	91
2	265	91
3	62	92
4	30	88
5	18	82
6	12	77
7	7	70
9	3	64
10	2	57

It will be seen from the above table that during July-August, comparatively very few observations are available with pilot balloons for levels above 2 km which represent approximately the height of base of cloud above sea level (Height of Poona 560 metres). Whatever observations are available will be representative of only clear weather which is not the normal feature of the season. On the other hand, the number of observations extending to 10 km for two seasons is comparatively very much larger with the radar. These data are described below in more detail.

Monthly means of upper winds were worked out for all the available radar data and are shown in Fig. 1. For purposes of comparison, the monthly means of the afternoon pilot balloon winds for the same period have also been included for the levels for which radar winds are available. In the same diagram the normal upper winds based on all afternoon pilot balloon ascents up to 1950 are shown. Fig. 2 shows the isopleths of east-west components of radar wind based on the monthly means for the period June 1949—November 1950.

It will be seen from these diagrams that the radar winds fairly agree with the pilot balloon winds up to about 2 km which represents approximately the base of clouds during the monsoon. The agreement is less aloft as pilot balloon observations represent the conditions during clear weather while radar observations include all types of weather. The degree of disagreement is a measure of the difference in the wind in the clear and cloudy conditions.

It is also observed from Figs. 1 and 2 that the westerlies extend to higher levels in the radar winds than those shown by the pilot balloons. The speeds are also in the main higher than those indicated by the pilot balloon up to about 5 km. These differences are seen more prominently in July and August. The radar winds show clearly that when the monsoon is active over Poona, it is approximately 6 km deep and blows from the west. Aloft, the wind changes sharply to east. The strongest westerly monsoon winds are of the order of about 40 kmph and occur during July between 1 and 3 km. The pilot balloon winds which on the other hand show the monsoon westerlies to be only about 4 km deep represent the conditions when it is weak and the skies are clearer.

Differences are observed in the wind speeds also. During August the radar winds are stronger than pilot balloon winds above 2 km up to about 5 km while, the pilot balloon winds are stronger aloft. One may, therefore, infer that during active monsoon, the winds are stronger up to about 5 km and weaker aloft than those occurring during weak monsoon.

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