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Radar climatology of Gauhati airport and its neighbourhood

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ABSTRACT. Radar observations at Gauhati Airport for the period of 51 months from March 1960 to October 1967 (excluding 1966) form the basis of this climatological study. Monthly and seasonal distribution of the precipitation echoes with respect to their areal coverage has been studied. The diurnal variation of the areal coverage by the precipitation echoes during the different periods of a day in a month has also been studied.

1. Introduction

Kulshrestha and Jain (1964) reported the results of their study of radar climatology of Delhi and neighbourhood based on the observations made with a high powered radar AN/CPS-9 at New Delhi. A somewhat similar study based on 7 years data in respect of Gauhati Airport and its neighbourhood has been made and the result of the study presented in this paper.

2. Location and climatology of the Gauhati Airport

Gauhati Airport (Lat. 26° 05′N and Long. 91° 43′E) is situated at the foot of Garo-Khasi Jaintia range in the Brahmaputra valley. The *Brahmaputra* river flows from east to west in the north of Gauhati. Towards north is also the great Himalayan range. A schematic diagram showing the topography of Gauhati Airport and its surroundings is presented in Fig. 1.

During the pre-monsoon season (*i.e.*, March—May), the station experiences a lot of thunderstorm activity. Normally, the monsoon settles over the region during the 1st week of June and withdraws by the 1st week of October. Gauhati Airport and its vicinity experience appreciable amount of rainfall, the average rainfall in the pre-monsoon, monsoon and post-monsoon (October only) seasons being 150·0, 262·0 and 90·1 mm respectively. The winter season starts from the month of November and there is practically no rainfall activity from November to February.

3. Data

The Meteorological Office at Gauhati was equipped with a 3-cm radar (Decca Type 41) having the detecting range of 150 n. miles from 1960 to 1965. It was replaced by another 3-cm radar (Bendix WTR-1) having an effective range of 100 n. miles.

The radar was operated every hour from 0400 to 2200 IST during 1960. Round-the-clock hourly radar observations were taken during the subsequent years. All the PPI presentations of the hourly radar observations were carefully copied on polar diagrams. The data presented in the note have been collected from these polar diagrams.

The available data from 1960 to 1967 (excluding 1966, when the radar was inoperative) have been analysed. The data for five months (March 61, March 62, June 62, March 65 and April 67) were not available. During the fair weather period (November to February), the radar is not operated on a regular basis and as such no analysis of the data during the period has been made.

4. Analysis of the data

It is worthwhile to mention that the radar study presented in this communication suffers from certain limitations. The probability of detection precipitation by a radar (*i*) decreases rapidly with increasing distance because of "inverse square law" and also because of the earth's curvature, (*ii*) is unequal in different directions because of the topography of the area and (*iii*) is affected by attenuation of the radar beam due to intervening precipitation. As such, the areal distribution of radar echoes might not be taken as a true indication of the areal distribution of precipitation.

As stated earlier, the analysis of the data has been done in a somewhat similar way to that of Kulshrestha and Jain (1964). Each polar diagram was arbitrarily divided into 48 sectors upto the range of 80 n. miles, each sector being bound by a 30° radial line and 20 n. miles concentric range ring. A sector was counted as fully covered if it was half or more covered by the precipitation echoes. The number of times each sector thus covered during the different observation of the each month was found out

Fig. 1. Topography of Gauhati Airport and its surroundings

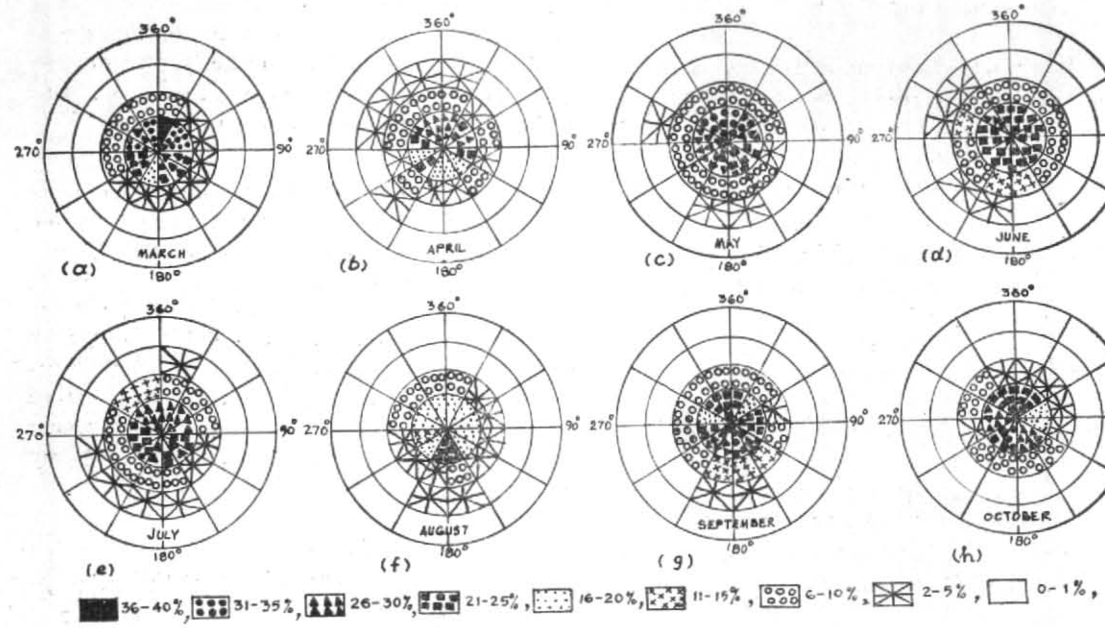

Fig. 2. Monthly percentage distribution of precipitation echoes

The rings are 20 n. miles apart

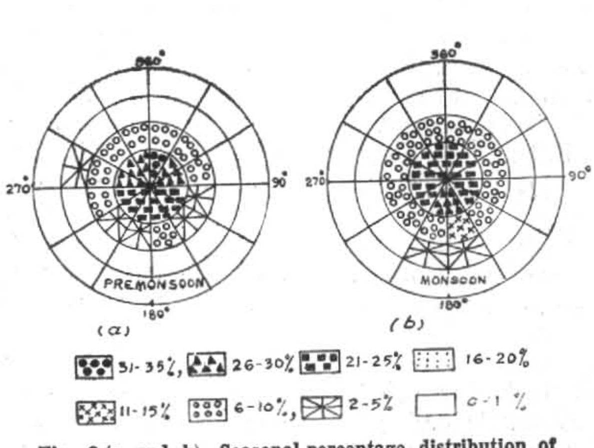

Fig. 3 (a and b). Seasonal percentage distribution of precipitation echoes

The rings are 20 n. miles apart

From the data thus collected, the average percentage frequencies of each sector being filled by the precipitation echoes during any observation in a particular month was found out (Figs. 2a —2h). In order to determine the distribution of the percentage frequencies during different seasons, these average monthly frequencies were combined (Figs. 3a and 3b).

In order to study the seasonal variation of the areal coverage, the period from March to October has been broadly divided into the following three seasons —

(*i*) Pre-monsoon — March to May

(*ii*) Monsoon — June to September

(*iii*) Post monsoon — October

To study the diurnal variation, a day has been divided into five broad periods (De and Bhattacharyya 1966) as detailed below. While making this division due consideration has been given to the geographical location of the station —

Morning	0531-0830 IST
Noon	0831-1230 IST
Afternoon	1231-1730 IST
Evening	1731-2030 IST
Night	2031-0530 IST

During these periods, the average number of occasions during a particular month, when any of the sectors was fully covered, were found out. These have been plotted in Fig. 4 [Mar to Oct]. The sectors which have an average of less than one occasion have been neglected.

5. Discussion

(a) *Monthly distribution pattern* — A study of Fig. 2 (a-h) reveals a statistical picture of the coverages by precipitation echoes during the different months of the year. A month by month study of these figures brings out the following important features —

(*i*) *March* — The frequency of the occurrence of precipitation echoes is maximum in the NNE direction and minimum in the SSW direction near the station. The areal coverage in the region between 240° and 030° azimuth and between 20 and 40 n. miles from the station is very small. Beyond 40 n. miles, the areal coverage is negligible (Total No. of observations analysed were 191).

(*ii*) *April* — The frequency of occurrence of the precipitation echoes shows a decreasing trend in most of the sectors near the station, though the areas of maximum and minimum occurrence is still in the north and south directions respectively. There is, however, an increase in the frequencies in the SW and SE sectors which are between ranges of 20-40 n. miles. The areal coverage between 40-60 n. miles ranges in the SW sector and in the region from 270° to 030° azimuth also shows slight increase (Total No. of observations analysed for this month were 250).

(*iii*) *May* — The frequency of occurrence of precipitation echoes near the station during this month again shows an increasing trend, but the pattern of maximum and minimum occurrence of frequencies remains more or less the same. It may be noted that the frequency of the occurrence of precipitation echoes in the southerly sectors between 20-60 n. miles has also slightly increased (Total No. of observations analysed were 550).

(*iv*) *June* — There is a considerable change in the frequency distribution pattern as compared to that of May. The areal coverage of precipitation echoes is now almost evenly distributed except in the NW sector, where it is slightly more. The frequency of occurrence in the southerly and WNW sectors at ranges of 20-40 n. miles also shows an increase. This is according to expectation as the monsoon advances during this month over the Brahmaputra valley in Assam (Total No. of observations analysed were 769).

(*v*) *July* — The frequencies exhibited in this month are higher in most of the sectors near the station. In the ranges between 20-40 n. miles from the station, the observed frequencies of the precipitation echoes have slightly decreased in the southerly sectors. However, the frequency in the southerly direction between the ranges 40-60 n. miles shows a slight increase.

The monsoon is at its peak in this month and the frequency should have also increased in all the sectors beyond 20 n. miles. But this expectation has not been borne out by the present study. The reason might be due to the effect of attenuation of radar beam due to heavy precipitation (Total No. of observations analysed were 941).

(*vi*) *August* — This month exhibits a general decrease in the sectors near the station. The frequencies in the southerly sectors show, however, slightly higher values than in the other sectors (Total No. of observations analysed were 979).

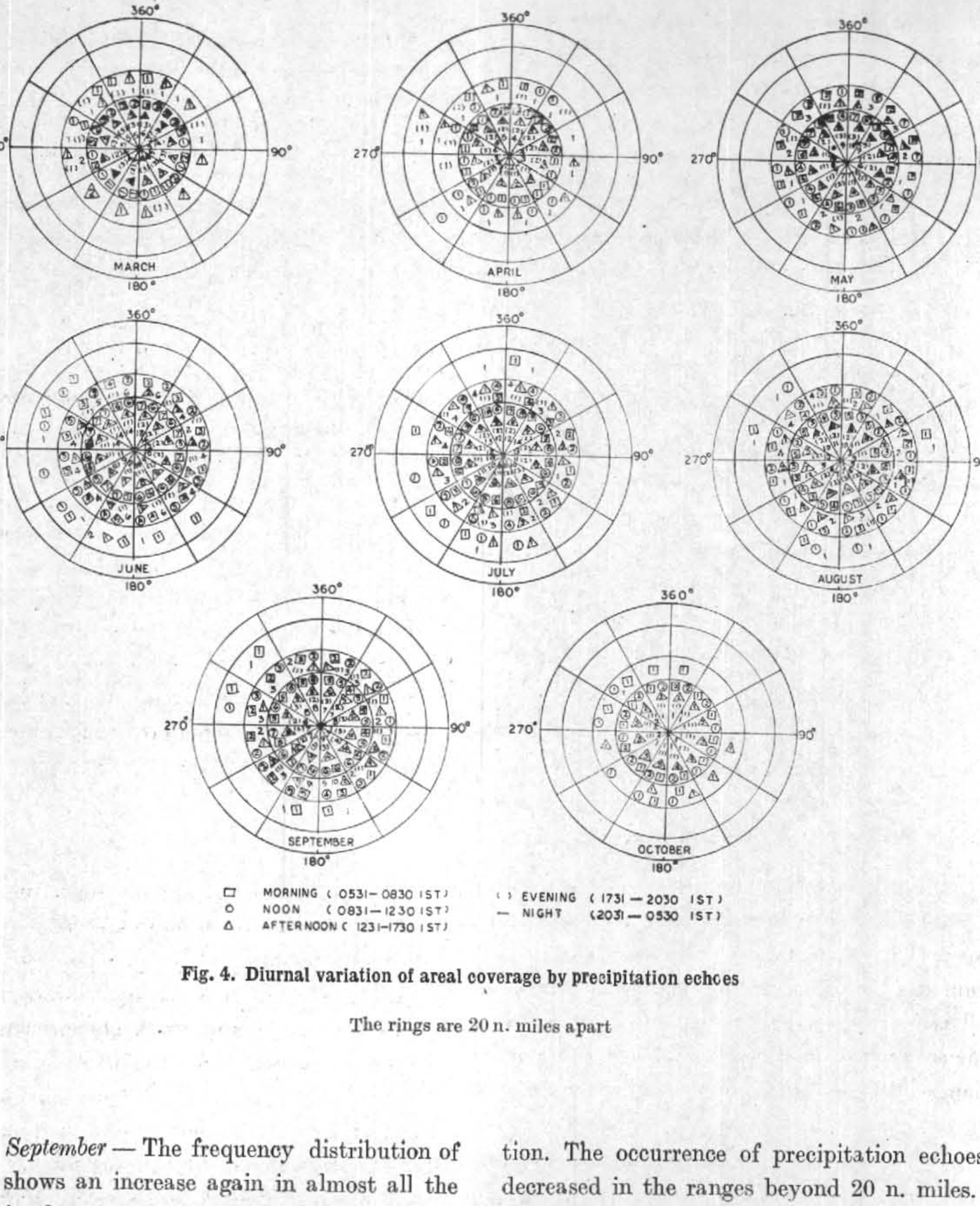

Fig. 4. Diurnal variation of areal coverage by precipitation echoes

The rings are 20 n. miles apart

(*vii*) *September* — The frequency distribution of echoes shows an increase again in almost all the sectors in the ranges upto 40 n. miles. However, the sectors of maximum occurrence are now southerly (Total No. of observations analysed were 642).

(*viii*) *October* — The frequencies exhibited during this month are also higher in the southerly direction. The occurrence of precipitation echoes has decreased in the ranges beyond 20 n. miles. This is according to expectation as the monsoon usually withdraws over the Brahmaputra valley in the first week of this month (Total No. of observations analysed were 228).

(*b*) *Seasonal distribution pattern* — Figs. 3(a), 3(b) and 2(h) reveal the distribution of frequencies of precipitation echoes in pre-monsoon, monsoon and post-monsoon seasons. Certain important features are summarised below —

(*i*) *Pre-monsoon Season* — The distribution of frequencies in the northerly direction is greater than in the southerly direction, the maximum frequency being in the NNE direction. The pattern shows that much of the pre-monsoon activity is in the north in this season.

(*ii*) *Monsoon Season* — Because of the influence of the monsoon activity, the frequencies are almost uniformly distributed in the region except in southerly direction, where the frequencies are slightly higher.

(*iii*) *Post-monsoon Season* — The change from monsoon to winter over Assam is rather sudden and post-monsoon thunderstorms are few as pointed out by Mukherjee *et al.* (1964). By the end of October, precipitation activity almost comes to an end and fair weather season starts. The features of frequency distribution during this season are already discussed under the month of October.

(*c*) *Diurnal Variation* — Fig. 4 [Mar to Oct] gives the average number of occasions in a month when the particular sector was full in any of the five periods of the day. The study of these frequencies reveals the following features.

(*i*) *Night (2031-0530 IST)* — The areal coverage is maximum during the night time in all the months except August, September and October. The maximum number of occasions, when the sectors are full is in the northerly direction from March to August. In the month of September, the pattern changes, which shows almost equal coverage in all the sectors. In the month of October, the areal coverage is slightly more in the west direction.

(*ii*) *Morning (0531-0830 IST)* — During March, April, May, July and August the areal coverage is more in the northerly direction in the morning. In June and October the areal coverage does not show any clear predominance of any sector, but in September the areal coverage in the southerly direction is more. In the month of May, the areal coverage during morning shows significant increase in all the sectors and is only slightly less than that of the night time.

(*iii*) *Noon (0831-1230 IST)* — The areal coverge shows much decrease during this time of the day as compared to the morning time. In the months of March, April, June, July and October there is no significant predominance of any of the sectors. In May the northerly sectors show slight predominance over the other sectors in the areal coverage. In August and September, the areal coverage is more in the southerly direction.

(*iv*) *Afternoon (1231-1730 IST)* — The areal coverage again shows slight increase now in all the sectors in all the months except April as compared to that of the noon. There is much increase in the areal coverage in the southerly sectors in all the months except March and April which do not show any clear predominance of any sector.

(*v*) *Evening (1731-2030 IST)* — The areal coverage is minimum of the day. There is no clear predominance of any sector over others in all the months except May, where the northerly sectors show very slight predominance in the areal coverage near the station.

6. Concluding remarks

The object of the present study, in the climatological sense, has been to give an overall picture of the distribution of the precipitation echoes and the time variation of the precipitation echoes at Gauhati airport and its neighbourhood. It may, however, be stated that the detection of the echoes beyond the ranges of 40 n. miles from the station appears to be very much limited by the attenuation of the radar beam by the nearby echoes. Assam region experiences a widespread rainfall activity during monsoon and as such, it is felt that the areal coverage by the precipitation echoes beyond 40 n. miles may not have been brought about clearly due to this limitation. It may also be mentioned that beyond ranges of 60 n. miles from the station, there were only a few occasions when the sectors were found fully covered with precipitation echoes.

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