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April global radiation in relation to subsequent monsoon rainfall in India

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ABSTRACT. Monthly mean global radiation charts for the months March to May are examined year by year for the period 1960 to 1975 in relation to the behaviour of the subsequent monsoon rainfall in the country. April charts show a region of high radiation extending from Rajasthan to Tamil Nadu through the Deccan plateau in the years when the subsequent monsoon rainfall is normal over the country. In deficient years, *viz.*, 1965, 1966 and 1972 the pattern changes substantially; a tongue of low radiation appears over the Peninsula and the Central parts of India. No such change in the radiation pattern is observed in the preceding and the succeeding months (*viz.*, March and May). However, similar pattern is observed in April 1970 also although this was a good monsoon year. In this connection, five-day mean radiation charts for the years 1970 (normal monsoon) and 1972 (drought year) have also been examined. It has been found that in 1970, the region of high radiation appears over Deccan plateau during the last two pentads of April while this feature is not seen in 1972. April mean radiation chart may, therefore, serve as a clue for predicting the behaviour of the subsequent monsoon rainfall in the country.

1. Introduction

The influence of southwest monsoon rainfall on Indian economy is well known. Attempts are, therefore, being made by meteorologists to give an advance indication of the behaviour of southwest monsoon rainfall using different synoptic and statistical methods. All atmospheric processes and resultant weather phenomena are induced by solar energy reaching the earth. The effects of solar radiation during summer over India on the distribution of southwest monsoon rainfall is, therefore, receiving considerable attention by meteorologists in recent studies. Ramachandran *et al.* (1977) have shown that the variation of the mean global radiation during summer months (March to May) over different stations in India is small and does not have any significant correlation with variation of sub-divisional rainfall in the subsequent monsoon. Banerjee *et al.* (1976) have found a significant connection of monsoon rainfall with the position of the sub-tropical ridge at 500 mb in the mean upper air circulation of the month of April. Although the year-to-year variation in radiation values is small, the authors have observed on critical analysis of the radiation charts that there is a significant change in the pattern of the distribution of radiation from year to year during summer months particularly in April. This led the authors to see whether the global solar radiation in the months of April can give any indication about the behaviour of the subsequent monsoon rainfall. The results of the above investigation have been discussed in the following sections

2. Methodology

Continuous monthly global solar radiation data are available for about 15 stations distributed over India for about fifteen years and these data have been utilized for the present study. The locations of these stations are shown in Fig. 1. The mean monthly global radiation values for each of the months, March to May for these stations have been plotted and analysed year by year for the period 1960 to 1975. The normal charts for these months have also been prepared on the basis of data for 1960 to 1975.

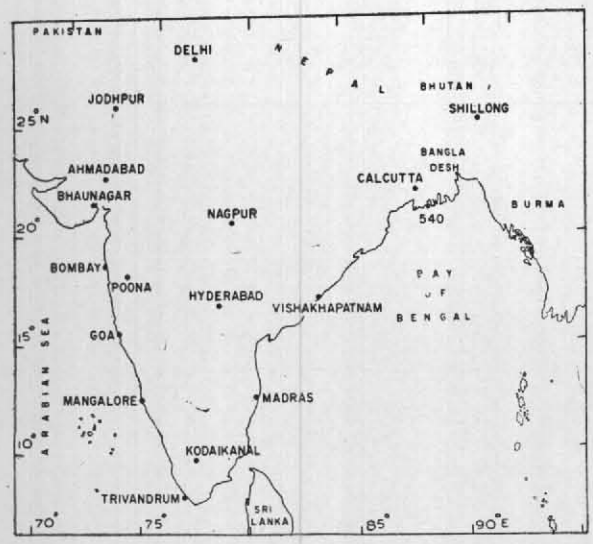

Fig. 1. Location of radiation stations

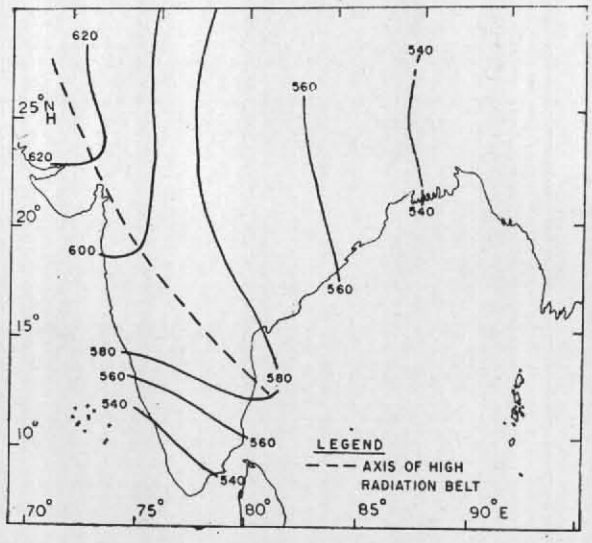

Fig. 2. Mean daily normal global solar radiation (cal/cm^2) pattern for the month of April (1960-75)

The pattern of global radiation in the monthly charts (March to May) for each year from 1960 to 1975 is examined in relation in the behaviour of the subsequent monsoon rainfall distribution in the sub-divisions of India. For this purpose, percentage departure from normal of June-September rainfall in various sub-divisions are considered and the usual departmental conventions, namely, departure from normal +19 per cent to —19 per cent; +20 per cent and above and —20 per cent and below have been taken respectively as normal, excessive and deficient rainfall for each sub-division. In addition to this, pentad radiation charts for the months March to May for 1970 (good monsoon year) and 1972 (drought year) have also been prepared and analysed.

3. Results and Discussion

It is observed that year-to-year variations in the distribution of radiation pattern for the months of March as well as May do not have any bearing on the distribution of subsequent monsoon rainfall (June to September) over the country. However, the year-to-year variations in radiation pattern for the month of April show some relationship with the distribution of subsequent monsoon rainfall over the sub-divisions of India. The mean daily normal global solar radiation pattern for the month of April (averaged over the years 1960 to 1975) is shown in Fig. 2. It is observed that the axis of the high radiation belt runs from Rajasthan to Tamil Nadu, through the Deccan plateau. In the year when the April radiation pattern more or less conforms to its normal pattern, the subsequent rainfall in the monsoon season is also found to be normal or in excess in more than 90 per cent of the sub-divisions in India. But in those years when the axis of the high radiation belt shifts westwards from normal position, the subsequent monsoon rainfall is found to be deficient in about 20 per cent of the sub-divisions in the country. The position of the axis of the radiation belt in two typical years when the rainfall is normal or in excess in all the sub-division (1975) and 84 per cent of sub-divisions (1969) *vis-a-vis* the normal axis is shown in Figs. 3 and 4 respectively. It is interesting to note that in the years when the monsoon rainfall is highly deficient over the country, the radiation pattern in April undergoes radical change. The axis of the high radiation belt breaks or shifts very much towards the west and a tongue of low radiation appears over Deccan plateau and adjoining area. Two typical examples of this are shown in Figs. 5 and 6.

In Table 1 the year-to-year deviation of April radiation pattern from the normal and the subsequent monsoon rainfall for the available years 1960-1975 are shown.

It may be seen from Table 1 and Fig. 7 that the radiation pattern of 1970 shows a tongue of low in Deccan plateau and the adjoining areas as in the drought year 1972 indicating that the subsequent

TABLE 1

Year-to-year deviation from normal of high radiation belt and distribution of the subsequent monsoon rainfall

Year	Position of axis of high radiation belt	Overall deviation from normal axis of high radiation belt	% No. of subdivisions having normal or excess rainfall during Jun to Sep
1960	Jodhpur to Madras through Malegaon, Hyderabad	More or less normal	100
1961	Ahmedabad to Madras through Surat, Sholapur, Anantpur	More or less normal	94
1962	Udaipur to Nellore through Malegaon, Hyderabad	More or less normal	94
1963	Barmer to Madras through Sholapur, Anantpur	More or less normal	94
1964	Jodhpur to Madras through Malegaon, Hyderabad	More or less normal	97
1965	Along the west coast	Much to the west of normal position; appearance of low tongue of radiation in Deccan plateau	55
1966	Northern position of the axis along west coast upto Goa breaking off thereafter	Much to the west of normal position; appearance of low tongue of radiation over Andhra Pradesh, Kerala, Tamil Nadu	64
1967	Jodhpur to Nellore through Akola, Hyderabad	More or less normal	97
1968	Barmer to Trivandrum through Pune, Gadag & Cochin	Much to the west	68
1969	Ahmedabad to Pamban through Pune, Gadag & Ootacamand	Slightly to the west	84
1970	In Arabian Sea off the west coast	Very much to the west; appearance of low tongue of radiation between 75° and 80°E over central India and south Peninsula	100
1971	Barmer to Madras through Surat, Pune, Gadag	Slightly to the west	77
1972	Arabian Sea off the west coast	Much to the west of normal; appearance of low tongue of radiation over eastern part of India	32
1973	Barmer to Madras through Ahmedabad, Aurangabad	More or less normal	97
1974	Axis broken	Appearance of low tongue of radiation over central & south Peninsula	63
1975	Ahmedabad to Nellore through Malegaon and Hyderabad	More or less normal	97

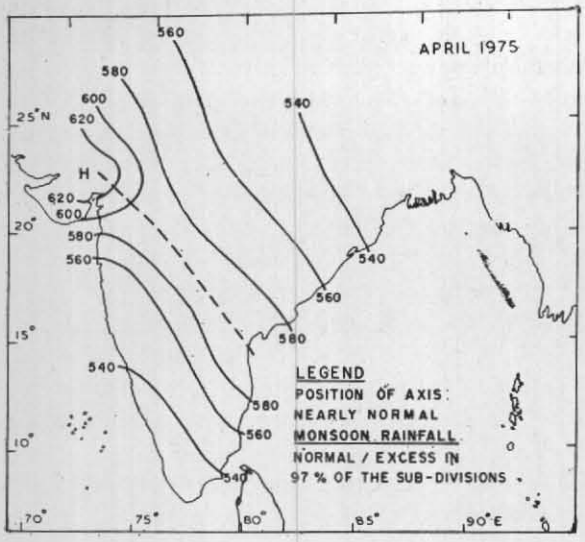

Fig. 3. Mean daily global solar radiation pattern in April 1975

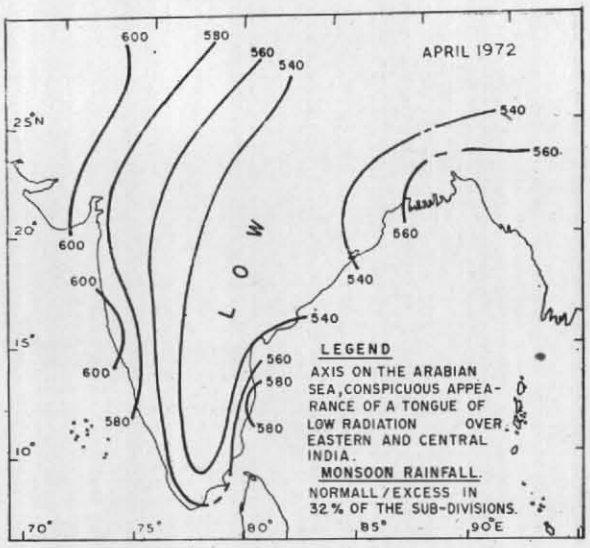

Fig. 5. Mean daily global solar radiation pattern in April 1972

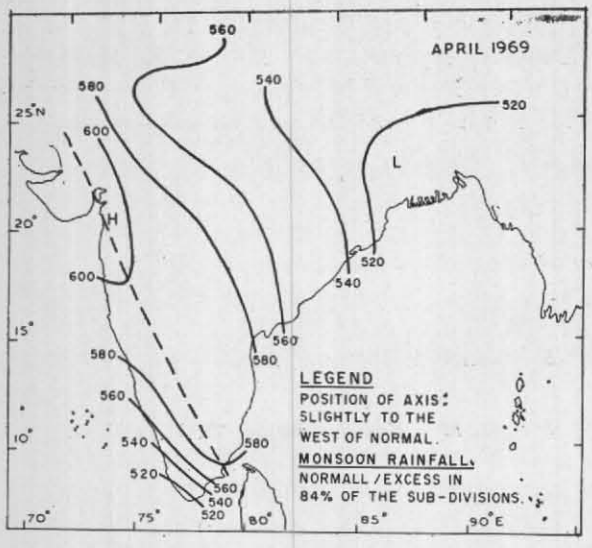

Fig. 4. Mean daily global solar radiation pattern in April 1969

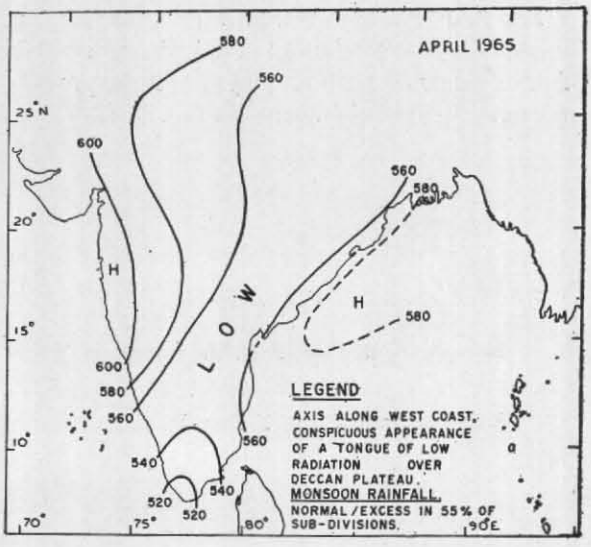

Fig. 6. Mean daily global radiation pattern in April 1965

monsoon rainfall would be highly deficient over the country. But actually 1970 monsoon rainfall was good and well distributed over the country. So to examine this peculiar anomaly, five-day pentad charts of April for the years 1970 and 1972 (a drought year) have also been studied. It is found in 1970 that although in the mean monthly chart, the belt of high radiation across the Deccan plateau is not reflected, the region of high radiation did appear over the Deccan plateau during the last two pentads of April. But in the drought year 1972, it did not appear in any of the pentads.

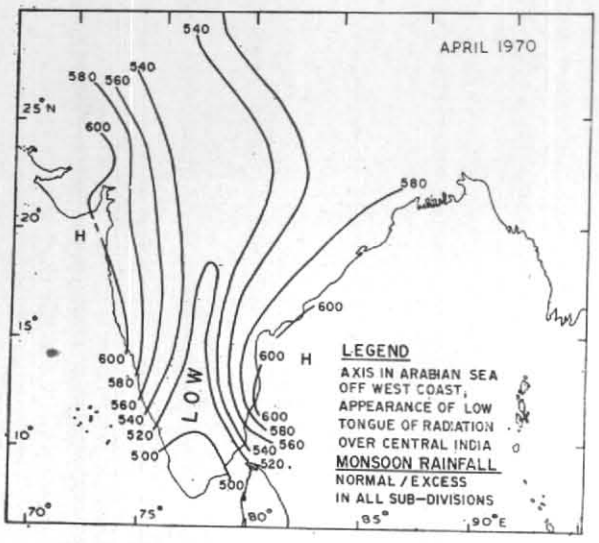

Fig. 7. Mean daily global solar radiation pattern in April 1970

4. Conclusion

The study has shown that in mid summer, *viz.*, in April, the deviation of the high radiation belt from its normal position plays an important role in relation to the subsequent monsoon rainfall over the country. The axis of the high radiation belt in April generally lies more or less in the normal position, *viz.*, in 1960 to 1964, 1967, 1973 and 1975 and in these years normal or excess rainfall is realised in more than 90 per cent of the sub-divisions in the country. But when the axis shifts or breaks or a low tongue of radiation appears in the Deccan plateau only about 30 to 60 per cent of sub-divisions in the country receive normal or excess rainfall, *viz.*, in 1965, 1966 and 1972. Even in the anomalous year 1970, the radiation belt did appear in the last two pentads of that year. Therefore, the position of the high radiation belt over the Deccan plateau running from Rajasthan to Tamil Nadu may be considered as one of the useful factors to determine the distribution of subsequent monsoon rain over the country.

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