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Drought prediction in India from radiation parameters

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सार — इस अध्ययन में सन् 1961 से 1979 तक की अवधि के सभी उपलब्ध स्टेशनों के जनवरी से मई के कुल भूमंडलीय (G) एवं विसरित विकिरणों D के मासिक मानों का उपयोग किया गया है। उस उद्देश्य के लिए सूखे को एक ऐसी स्थिति के रूप में परिभाषित किया गया है कि देश के 20 प्रतिशत से अधिक क्षेत्र में वर्षा की कमी ऋतुनिष्ठ (मानसून) सामान्य वर्षा की 25 प्रतिशत से अधिक हो जाए। मासिक के साथ ही साथ दो ऋतुओं अर्थात सर्दी एवं मानसून-पूर्व के कुल भूमंडलीय विकिरण के सामान्य मानों से विचलनों का आरेख बनाया गया है और उसका विश्लेषण इस दृष्टि से किया गया है कि उसका कोई स्थानिक बंटन है या नहीं तथा उसका आगामी मानसून ऋतु में सूखा पड़ने के साथ क्या संबंध है। G के संचयी योगों और उसके संचयी विचलनों को अलग-अलग स्टेशनों के लिए आरेखित किया गया है। फिर उसका सूखे के संदर्भ में परीक्षण किया गया है। $\Sigma(D-\bar{D})/(G-\bar{G})$ का मान सर्दी एवं मानसून के महीनों के लिए विभिन्न स्टेशनों के सूचकांक के रूप में ज्ञात किया गया है। यहां शिरो रेखा सामान्य मानों को प्रदर्शित करती है। इन मानों को भारत में सूखे की घटनाओं से संबंद्ध करने के प्रयास किए गए हैं। लगभग एक ही याम्योत्तर पर देश के लगभग दो छोरों पर स्थित दिल्ली और त्रिवेन्द्रम के लघु तरंग विकिरण मानों का अलग-अलग विश्लेषण किया गया है। देश पर उष्मा की मात्रा का अनुमान इन दो स्टेशनों से प्राप्त मानों के अन्तर से लगाया गया है। ये मान जनवरी से मई तक ज्ञात किए गए हैं और फिर भारत में सूख के संदर्भ में इनका विश्लेषण किया गया है।

ABSTRACT. Monthly values of total global (G) and diffuse (D) radiation from January to May, for all available stations for a period 1961-79 have been utilised in this study. Drought, for this purpose, has been defined as a situation when over 20% of the area of the country had rainfall deficiency more than 25% of the seasonal (monsoon) normal. Departures from the normal value of total global radiation have been plotted, monthly as well as for the two seasons, *viz*, winter and pre-monsoon and analysed to determine if it's spatial distribution pattern bears any relationship with the drought occurrence in the succeeding monsoon season. Cumulative totals of G and it's cumulative departures for individual stations have also been plotted and examined in relation to drought. $\Sigma(D-\bar{D})/(G-\bar{G})$ has been obtained for winter and monsoon months for different stations as a sort of an index where the bar denotes normal values and attempt made to associate them with drought incidence in India. Short wave radiation values at approximately the same meridian but at nearly the two extremities of the country, *i.e.*, Trivandrum and Delhi, have been separately analysed. Heat contents over the country has assumed difference between radiation values at these stations. These values have been obtained from January to May and suitably analysed with respect to drought situations in India.

1. Introduction

Inspite of tremendous progress India has made since independence in developing water resources and irrigation potential, the agricultural production in the country continues to depend on the vagaries of monsoon. Large scale failures of rainfall during the kharif season, as it happened during 1972 and 1979 results in considerable fall in food production. The droughts in some parts or the other in India, off late, have become a common feature. Attempts have, therefore, been made by number of workers to forecast drought in India during the southwest monsoon from antecedent meteorological conditions and synoptic features (Banerjee *et al.* 1976). Emphasis has been shifted in recent years from basic meteorological parameters or circulation patterns to the solar radiation parameters, to forecast large scale monsoon failures (Sen *et al.* 1978, Chowdhury *et al.* 1981).

An attempt has been made in this paper to predict drought in India from global radiation received by different parts of the country.

2. Data material and method of analysis

Monthly values of global radiation from January to May for all available stations for a period 1961—79, have been utilised. Drought for this purpose has been defined as a situation when over 20% of the area of the country, the rainfall deficiency exceeded 25% of the normal June to September. Departures of global radiation were plotted, (monthly as well as for the two seasons, *viz.*, winter and pre-monsoon) and analysed to determine if its spatial distribution pattern bears any relationship with the drought occurrences in succeeding monsoon season. Cumulative totals of the global radiation and its cumulative departures for individual stations have also been plotted and examined.

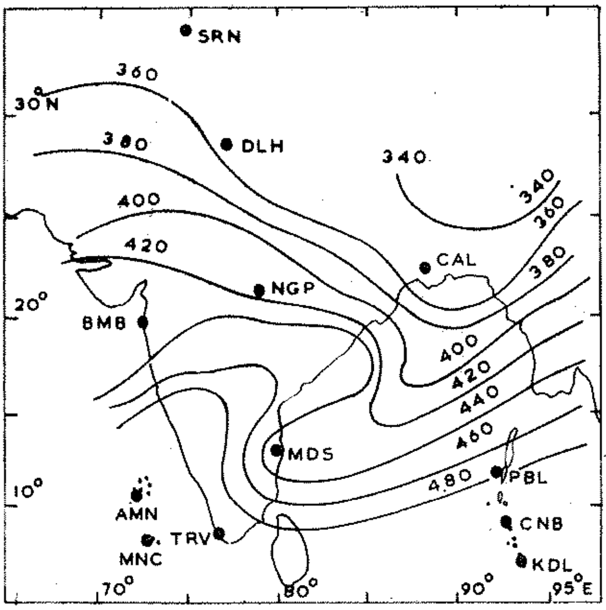

Fig. 1. Normal daily global radiation (cal/cm²) for January

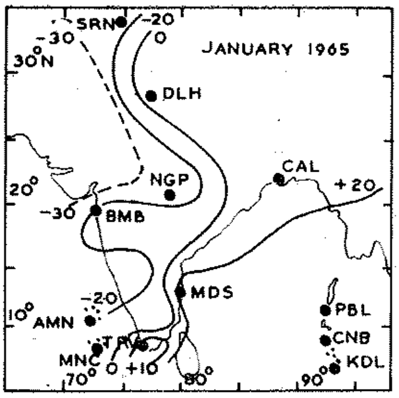

Fig. 2. Departures of global radiation (cal/cm²) for January 1965

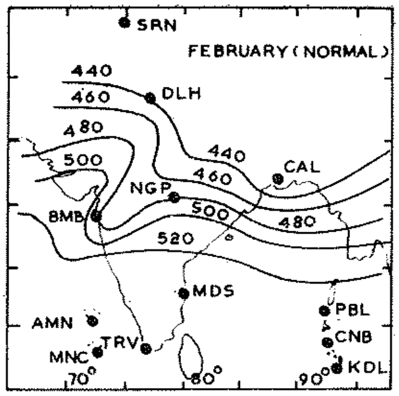

Fig. 3. Normal daily global radiation (cal/cm²) for February

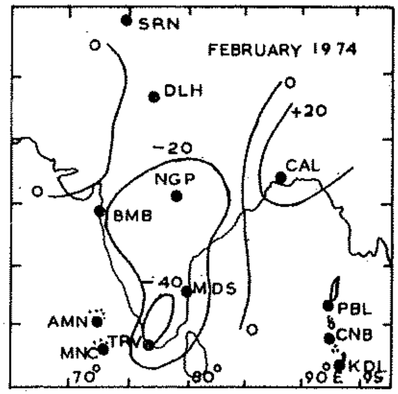

Fig. 4. Departures of global radiation (cal/cm²) for February 1974

3. Results and discussion

Large variations from one year to the other have been observed in the monthly departures from January to May in the global radiation. However, the pattern or rather the departures in January and February for individual stations located in northwest India and the Peninsula did provide some indications of the subsequent monsoon rainfall. These results are discussed below :

3.1. *Mean radiation pattern during January*

The daily normal global radiation for the month January is depicted in Fig. 1.

It is seen that a trough in the radiation isopleths run from the head Bay to coastal Tamilnadu. Over the west coast upto about 15 deg. N, the radiation received is the highest.

The departures of the global radiation during the drought years, *viz.*, 1965, 1966, 1972 and 1974 were analysed. Though nothing specific could be identified which was common to all these years, it was observed that in most cases a belt of negative departures extended from northwest India (*i. e.*, Jodhpur, Ahmedabad) to Vidarbha (*i.e.*, Nagpur). Some times this belt extended further south upto Goa and Bangalore as it happened in 1965 (Fig. 2).

In years of good monsoon, *viz.*, 1964, 1975, 1976 etc the pattern was rather diffused.

3.2. *Mean pattern during February*

In the mean global radiation pattern during February (Fig. 3) a trough passing from north Konkan to northeast Madhya Pradesh is the only prominent feature. Also over the southern Peninsula, below 15 deg. N the radiation values are the highest, *i.e.*, over 520 cal/cm^2.

When the departures from normal for good and bad monsoon years were examined, the pattern in general was rather random and it did not provide any clue for drought prediction. However, negative departures over the south Peninsula (Fig. 4) as observed at Goa, Madras, Visakhapatnam were common features for many of the drought years (the February 1974 pattern is given below for this purpose).

In good years (*i. e.*, 1964, 1967, 1975 and 1976) in both the months (January and February), the pattern was rather diffused.

The departure from normal of the radiation pattern for each of the months March, April and May was complex and it was not possible to discriminate between good and bad monsoon years during these months. Similarly the seasonal pattern (winter and pre-monsoon) of global radiation or that of diffused radiation for individual months as well as the two seasons did not provide any hint. Moreover, the radiation difference worked out between Trivandrum and New Delhi for January to May months was found to be widely distributed in good and as well as bad monsoon years.

3.3. *Verification*

It, therefore, appears from the above that if during, January the departures of the global radiation for majority of the stations among Jodhpur, Ahmedabad, Nagpur, Bangalore, Goa and Bombay are negative and those for Goa, Bangalore, Madras and Visakhapatnam are also negative in February, the year may witness drought conditions. These results have been tested for all stations for which the data was available for 1979, the year in which monsoon failed over large parts of India. At Goa and Ahmedabad, large negative departures prevailed during January. These were also negative for February for Goa and Visakhapatnam.

Thus the departures of global radiation during January and February, perhaps, provides some prior indication on the activity of monsoon during succeeding June to September months.

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References

Banerjee, A. K., Sen, P. N. and Raman, C. R. V., 1976, On foreshadowing southwest monsoon with mid tropospheric circulation anomaly of April, Pre-publ. Sci. Rep. 76/8, India Meteorological Department.

Chowdhury, A., Abhyankar, V.P. and Phadke, M.V., 1981, Solar activity as a potential factor in foreshadowing drought in India, *Mausam*, **32**.

Sen, P.N., Ramchandra, G. and Banerjee, A.K., 1978, April global radiation in relation to subsequent monsoon rainfall in India, *Indian J. Met. Hydrol. Geophys.*, **29**, 448-452.