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ANOMALIES OF NET RADIATION DURING SOUTHWEST MONSOON OVER THE BAY OF BENGAL

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ABSTRACT

Fifteen years of data are used for obtaining the insolation under cloud conditions using the incoming Solar radiation values given by Budyko for clear sky conditions. Taking into account the effective outgoing radiation, the net radiation is estimated over the Bay of Bengal. The fluctuations of net radiation anomalies during different monsoonal conditions are investigated. Negative anomalies of net radiation of more than 40 w/m^2 are observed during the good monsoon year and positive anomalies of 20 w/m^2 during poor monsoon year. For the purpose of individual case study two synoptic disturbances with different intensities were selected and the behaviour of the anomalies studied.

Key-words : Net radiation, Anomalies, SW Monsoon, Bay of Bengal.

INTRODUCTION

The most important parameter in the study of the energy balance is not the incoming radiation but the net radiation which will be utilized by the ocean surface for various processes that are occurring at the Air-Sea interface. The net radiation is made up of the difference between the incoming solar radiation and the outgoing terrestrial radiation. The study on the net radiation of the underlying surface is of extreme importance, as the net radiation is the main determinant of the climate.

MATERIALS AND METHODS

The region of study extends from 5 ° to 21 °N and 80 ° to 100 ° E. The entire region has been divided into 2° quadrangles. The data on Sea surface temperature, dry and wet bulb temperature and cloudiness for a period of fifteen years used in this investigation were obtained from Marine section, India Meteorological Department, Pune. In order to obtain the net radiation, the total incoming Solar radiation is evaluated during Southwest monsoon period by taking the radiation data given by Budyko (1956) for clear sky conditions for the latitudes under study. To obtain the incoming Solar radiation for an average cloud condition the Savinov Angstrom formula

$$(Q+q) = (Q+q)_c [1-(1-k) n]$$

is used. An albedo of 6% is used for the region under study as given by Budyko. The effective back radiation depends mainly upon the temperature of Sea surface and atmospheric water vapour content. The emissivity of the Sea surface to be black, the error involved is less than the supposed one. According to Swinbank (1965) the error involved is greatest with a clear sky. Infact the outgoing radiation is over estimated by about 1 percent. Summarising the results of observations of effective back radiation against the clear sky, from

a black body of different temperatures and at different vapour pressures a figure was prepared (Sverdrup, Johnson and Fleming, 1942) and used in this work to compute the effective outgoing radiation. The presence of cloudiness is studied by using an impirical relationship

$$Q_b = Q\,(1-0\,0873)\,C$$

where Q is the back radiation for a clear sky conditions, C is the cloudiness on the scale 1–10.

The net absorbed radiation by the sea surface or net radiation is obtained by subtracting the effective outgoing and reflected radiation from the incoming radiation.

RESULTS AND DISCUSSION

For the region under study the mean pattern of net radiation is taken from the studies of Veenadevi (1983). In May, a maximum net radiation of more than 150 w/m² was observed over the northern Bay of Bengal. With the onset of the Southwest monsoon a general decrease in the net radiation pattern occurs. When the monsoon is at its peak in July further reduction in net radiation was observed. The same picture was maintained in the month of August also. However during July and August maximum net radiation was observed over the western Bay of Bengal. In the month of September there was weakening of the monsoonal activity which resulted in a slight increase in net radiation. This can be particularly noticed over the extreme Southwest region.

Anomalies of net radiation are obtained and discussed in relation with the behaviour of Southwest monsoon. The three typical years representing good (1975), average (1978) and poor monsoon years (1976) are taken for this study. June and August months of each year are chosen for the above said study. The distribution of anomalies of net radiation is shown in Fig. (1). The year 1975 happened to be under the strong monsoonal activity and the net radiation anomaly pattern is negative throughout the Bay of Bengal excluding a small region in the east. This type of picture is present in both the months. During these months the maximum negative anomaly is observed over the northern Bay of Bengal covering the region of cyclogenesis (Koteswaram, 1963). During June three depressions are developed around the region of cyclogenesis compared to a single cyclone in August. Under these conditions during June large negative anomaly values of 40 w/m² were observed throughout the western Bay of Bengal whereas the maximum anomaly of 40 w/m² in August is limited only to the northern region of the Bay.

The year 1978 is considered to be having an average monsoon activity. In Fig. (1b) it is observed that during June a single depression is identified just south of the region of cyclogenesis and two weak depressions are developed in the region of cyclogenesis during August. In both the cases negative anomaly values are observed over the northern Bay with higher values in August. The southern region of Bay of Bengal during both the months is maintaining more or less positive values.

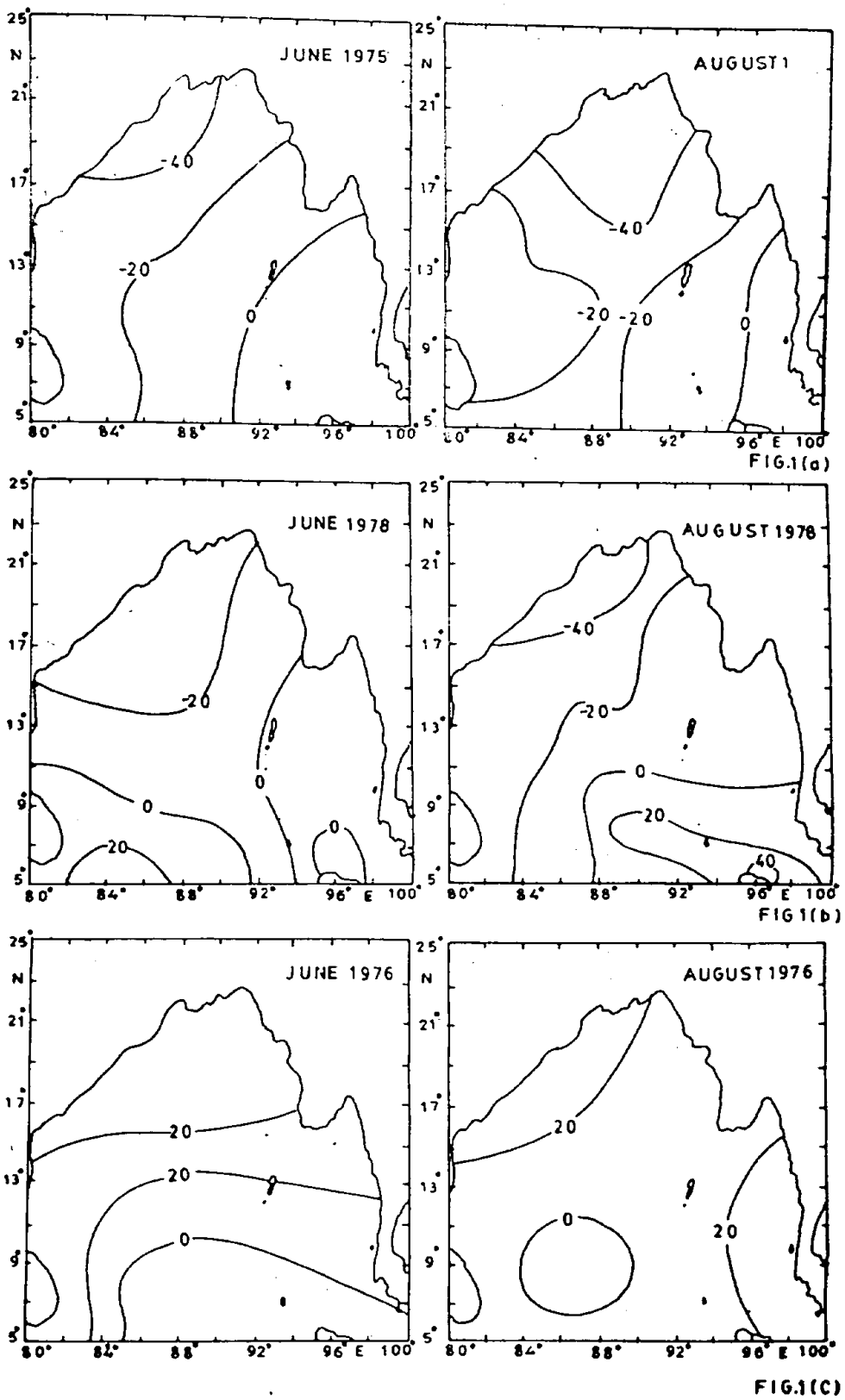

Fig. 1. Net radiation anomalies, w/m^2 (a) Good monsoon year 1975 (b) Average monsoon year 1978 (c) Poor monsoon year 1976.

The year 1976 represented poor monsoon activity. During this period a complete change in the anomaly pattern was observed. Positive net radiation anomalies were prevailing throughout the Bay of Bengal excluding some areas in the South. During both the months a region of maximum positive anomaly of more than 20 w/m^2 was noticed over the northern Bay of Bengal covering the region of cyclogenesis.

Two synoptic disturbances of different intensities occurring in different years are selected to study their effect on net radiation anomalies. A depression is located at 19° N 92° E on 8th September, 1977. The net radiation anomaly distribution has been presented in Fig. (2). It is seen from the figure that

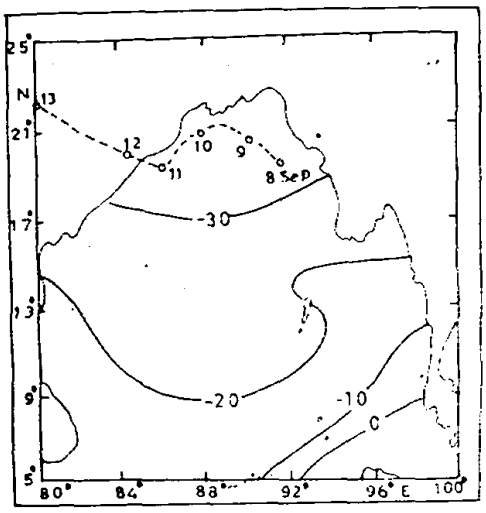

Fig. 2. Net radiation anomalies–8 Sep. 1977 depression (w/m^2)

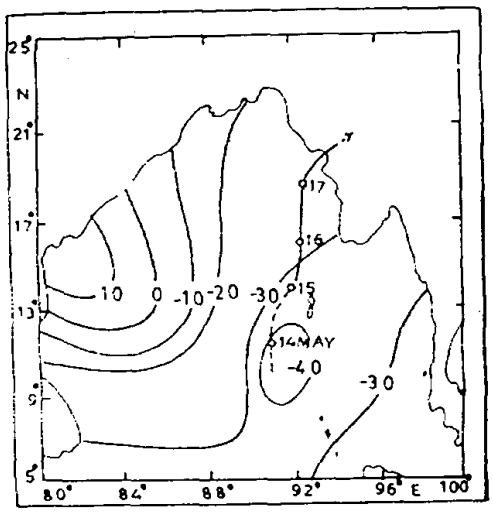

Fig. 3. Net radiation anomalies–14 May 1978. Storm (w/m^2)

negative anomalies prevail over the Central Bay of Bengal excluding a small area in the Southeast. The negative anomalies have increased in the northerly direction reaching a maximum of more than 30 w/m^2 at the head of the Bay of Bengal. This region of maximum negative anomaly has given rise to the depression. The depression even after entering the region of cyclogenesis, has continued to be a depression only. After changing the direction slightly with a westward motion it crossed the coast.

On 14th May, 1978 a depression developed at 11° N 91° E. Fig. (3) indicates the net radiation anomaly from the mean before the cyclone is identified. It is observed that in the northwestern Bay i.e. off the eastcoast of India positive anomalies were prevailing whereas over the rest of the region, negative anomalies were observed. The depression developed from the region which is just to the south of the region of cyclognesis with a maximum negative anomaly of 40 w/m^2. After entering the region of cyclognesis it developed into a severe cyclonic storm and travelled northerly and crossed the coast on 18th May, 1978.

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