551.521.9 : 551.581(540)

STUDY OF RADIATION CLIMATOLOGY OF INDIA

Systematic studies of solar radiation over India were possible only since the period of IGY when a large number of radiation detectors of a particularly selected design were established in India. Several studies have been made in the past (Chacko and Desikan 1965; Ayyar and Krishnamurty 1968; Garg and Gupta 1969; Yadav and Sinha 1969; Desikan *et al.* 1969). The spatial and temporal variations of turbidity coefficient 'β' has also been studied (Angstrom 1961; Mani and Chacko 1963; Chatterjee *et al.* 1983).

Recently Chatterjee *et al.* (1983) has performed the study of turbidity coefficient 'β' and ratio of diffuse to global solar radiation (D/T) for New Delhi, and found that 'β' varies with time and shows, similar variation as D/T.

The present report makes a comparative study of solar radiation for Indian stations. The averages published by India Meteorological Department for all the parameters, averaged over at least for 5 years between the period 1957 & 1975 have been utilized.

In this study 8 Indian stations, *i.e.,* Trivandrum, Madras, Visakhapatnam, Bombay, Calcutta, Nagpur, Ahmedabad and New Delhi have been considered as representative stations of India. These stations are spread in latitude between 8° N and 28° N covering most of the India.

2. *Global radiation* (T) — A comparative study of global radiation "T" for all 8 stations has been made. The averages of daily total global radiation for each month in cal/cm²/day averaged over the period mentioned in figure is plotted for the all stations in Fig. 1. From this figure it is clear that the global radiation attains its maximum values at Ahmedabad (642), New Delhi (610), Bombay (600), Nagpur (586), Visakhapatnam (564), Calcutta (550) in the month of May, at Madras (585) in the month of April and at Trivandrum (561) in the month of March. Ahmedabad receives

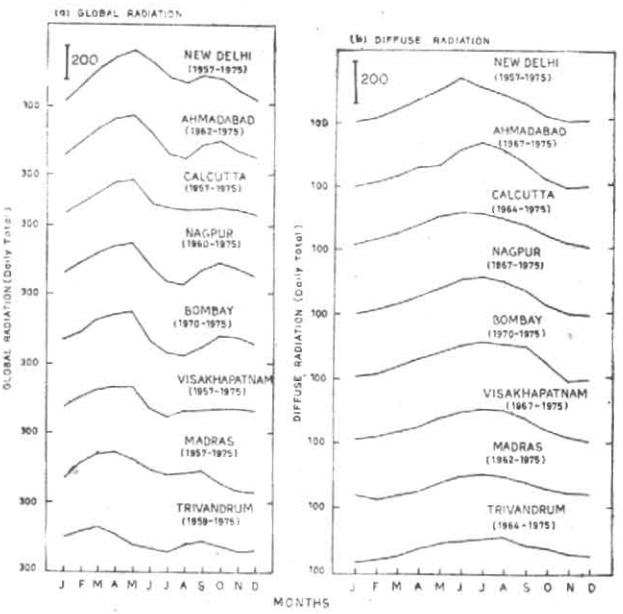

Fig. 1 Fig. 2

Monthly variation of daily total values of global solar radiation (T), & diffuse radiation (D) averaged over the period mentioned at respective stations

the maximum radiation throughout the year except during the monsoon months, July-August. The effect of disturbed weather at Bay of Bengal reflected in global radiation also at Calcutta, Madras, Bombay, Visakhapatnam and Trivandrum during the months of September-December. The minimum radiation received in all the stations in the month of July-August. The reduced values of intensity of global radiation during the monsoon is because of clouds cover the sky.

3. *Diffuse radiation* (D) — The daily total values of diffuse solar radiation 'D' for each month in cal/cm²/day averaged over the period mentioned in figure for all 8 stations of India is plotted in Fig. 2. It is clear from this figure that, at all stations diffuse radiation is highest during the summer and monsoon months, April to

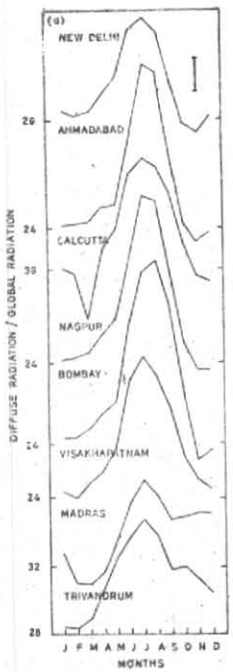

Fig. 3

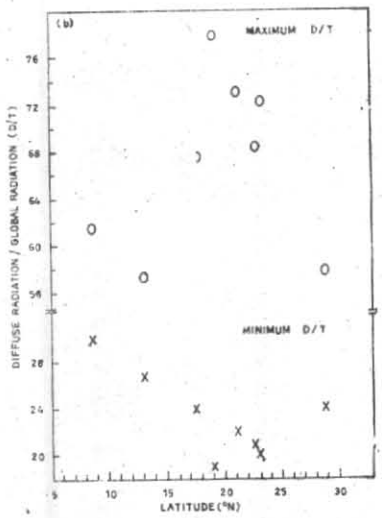

Fig. 4

Figs. 3 & 4. Monthly variation of D/T ratio (Fig. 3) and latitude variation of maximum values of D/T (at upper portion of Fig. 4) and minimum values of D/T (at lower portion of Fig. 4)

September and least during the clear winter months November to February. The highest values in the summer and monsoon periods are naturally due to increase turbidity, as cloudiness having the greatest influence on diffuse radiation. An exception is New Delhi, which receives the maximum diffuse radiation in the month of June, the hot summer month, when the atmosphere is very turbed and there are frequent dust storms. The highest values of diffuse radiation are at New Delhi (302) in the month of June, & at Ahmedabad (300) in the month of July. In the remaining stations, diffuse radiation is maximum in the month of July and is varying between 250 & 230 cal/cm^2/day.

The minimum diffuse radiation values received during the months of November-December. The lowest diffuse radiation values of $\approx$89 cal/cm^2/day are during November at Ahmedabad, New Delhi and Bombay. At remaining stations the lowest values are in the month of December. Trivandrum and Madras receive relatively uniform diffuse radiation throughout the year, as the result of more or less uniform clouding during the year.

4. *The ratio of diffuse and global solar radiation* (D/T)

Chatterjee *et al.* (1983) in his recent study for New Delhi shown that the ratio of D/T varies similar to that of turbidity coefficient 'β'. Because of that in this report D/T has been considered representative of 'β'. The D/T for all the stations under study are plotted in Fig. 3. From this figure it is clear that, the maximum values for all the stations occur in the month of July, except at Bombay where the D/T is maximum during the month of August. The D/T is minimum in the month of November at New Delhi, Ahmedabad, Bombay and Nagpur. At Calcutta Visakhapatnam, Madras and Trivandrum the D/T is minimum in the month of March. The variation in D/T is maximum at Bombay, where it varies from 19 per cent in the month of November to 80 per cent in the month of August and least at Madras where it varies only from 26 per cent in the month of March to 57 per cent in the month of July.

5. *Variation of D/T with latitude*

The maximum and minimum values of D/T ratio are plotted in a scattered diagram with respect to latitude in Fig 4. From this figure it implies that maximum values of D/T, *i.e.*, 'β' is not having any correlation with the latitude, while the minimum value of D/T ratio decreases with the increase of latitude.

6. *Conclusion*

(*i*) Ahmedabad receive maximum global radiation throughout the year except monsoon months and maximum during the month of May as all stations except at Madras and Trivandrum where global radiation is maximum during the month of April and March respectively.

(*ii*) Diffuse radiation is maximum in the monsoon season, where turbidity due to cloudiness is higher.

(*iii*) The ratio of diffuse to global radiation (D/T) which is the measure of turbidity coefficient 'β' is maximum during the month of July in all the stations except at Bombay where this is maximum during the month of August. Bombay is having more variation in D/T in comparison to other stations.

(*iv*) Maximum values of D/T, *i.e.*, maximum turbed condition is independent to latitude, however, the minimum turbidity D/T decreases with the increase of latitude.

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