551.573 (544.6)

THE TRANSPARENCY OF THE ATMOSPHERE OVER JODHPUR

Measurement of the intensity of direct solar radiation using Pyrheliometer and determination of Ångstrom turbidity coefficient β is being done at all principal radiation stations in India. β is a measure of the haze and dust content of the atmosphere. The determination of β involves measurements of solar radiation intensity in different wavelengths. The wavelength exponent α, a factor which depends on the size on the suspended particles in the atmosphere is assumed to be 1.3 which is just a mean value. In actual cases this can be quite different. β does not directly give an indication of the depletion of energy in the atmosphere. The values of β is seen to vary widely from observation to observation for which no physical reasoning can be attributed. An attempt has been made in this article to calculate the transparency of the atmosphere at Jodhpur during the year 1979 from direct solar radiation measurements without any filter, which are rather stable, and study the variation of the transparency with time and seasons.

Jodhpur situated in the arid Rajasthan region is selected . Due to the dusty atmosphere over the station, especially during summer season, wide variation in the transparency of the atmosphere is expected. The data for 1979 have been used for the calculation, as the monsoon was poor and hence, the aerosol content of the atmosphere is expected to be higher. Unlike β the transmission factor or transparency of atmosphere gives directly the depletion of incident solar energy and can be used as a measure of air pollution as well.

2. According to formula by Bouguer

$$I_m = I_0 q^m$$

Where, I_0 is the extra terrestrial intensity of solar radiation, I_m is solar radiation intensity after passage through optical airmass m and q is the transmission factor. The value of the solar constant is taken as 1.98 cal/cm^2/min which has been corrected for mean solar distance to determine I_0. I_m is the intensity of solar radiation as measured with Ångstrom pyrheliometer. m, the airmass or optical thickness, depends on the solar height, and indicates the thickness of the number of atmospheres through which the radiation has to pass through when compared to the overhead sun. m is greater than one.

Then, $$q = {}^{m}\sqrt{\frac{I_m}{I_0}}$$

q for each individual observation of Jodhpur for 1979 has been computed and used for this study.

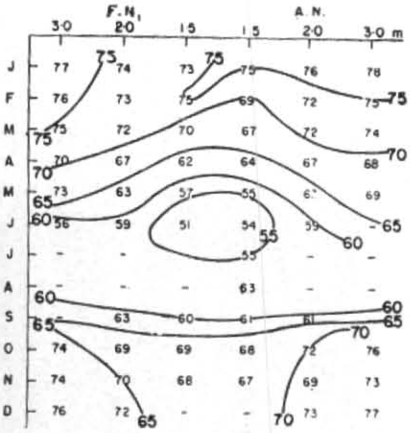

Fig. 1. Atmospheric transmission (%) at different air masses

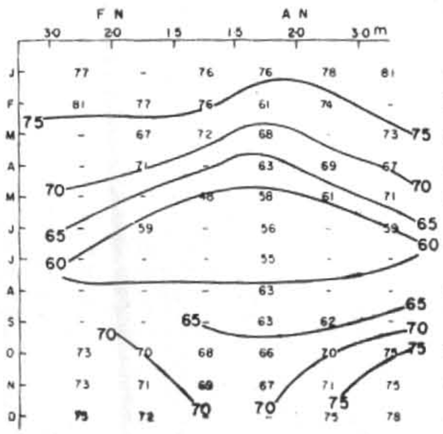

Fig. 2. Atmospheric transmission (%) at different air masses when clouds present

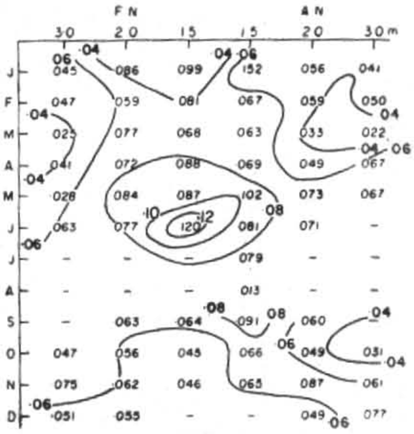

Fig. 3. Turbidity coefficient at various air masses

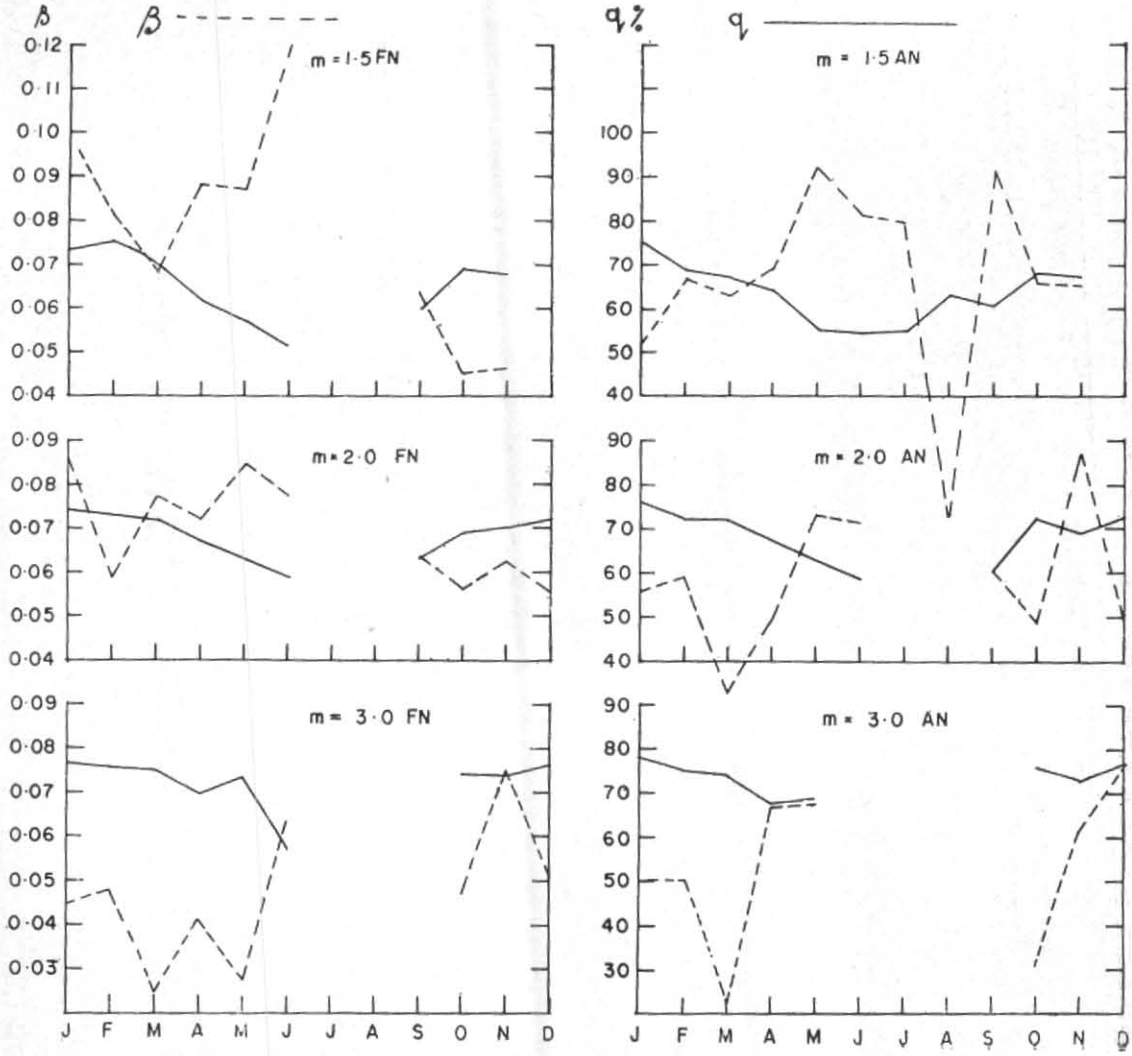

Fig. 4. Atmospheric transmission q and turbidity coefficient (β)

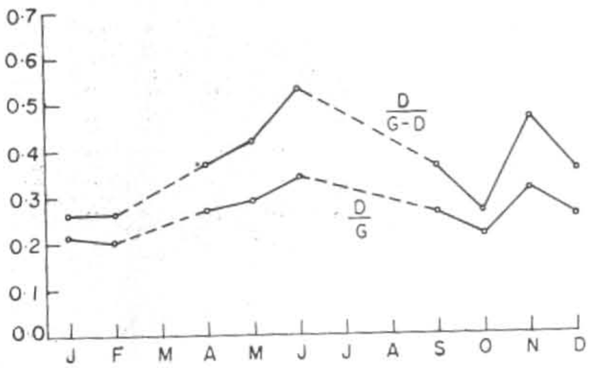

Fig. 5. Ratios of D/G and $D/(G\text{-}D)$

3. Pyrheliometer observations were taken at Jodhpur in 1979 six times a day corresponding to air masses 3.0, 2.0 and 1.5 before noon and 1.5, 2.0 and 3.0 in the afternoon. The observations are taken only when the sun and surroundings are free from clouds and there is no major weather phenomenon like rain, dust storm etc. Naturally very few observations are taken in the rainy season.

True solar time or the local apparent time are used for solar radiation measurements. Due to the seasonal variations which depends on the declination of the sun and the latitude of the place, 3.0 to 1.5 air mass occurs between nearly 0830 and 1130 LAT in January gradually changing to between nearly 0600 and 0800 in June and comes back to the original timing by December. But in December due to the low angle of the sun 1.5 air mass is not reached. The pattern is symmetrical in the afternoon.

4. The mean values of the transparency of the atmosphere for different air masses month by month is given in Fig. 1. Isolines have also been drawn in the figure. The observations are given below :

(*i*) It is seen that the transparency of the atmosphere decreases from winter till summer. This can be attributed to the increasing dust content of the atmosphere over Jodhpur.

(*ii*) After the wash-out in rainy season the dust settles down and atmosphere becomes more transparent

(*iii*) Early mornings and evenings the transparency is better when compared to high solar elevations. Rather, the transparency decreases from morning till noon and later increases. This could be due to convective activity at high temperatures at noon.

(*iv*) Although the observations have not been taken when clouds obstruct or is likely to obstruct the sun, the transparency when some clouds are present elsewhere in the sky is given in Fig. 2. The trends are same as that given above for Fig. 1. It is seen that generally the transparency is 1 or 2% better in the presence of clouds except in October when it is 1 or 2% poorer, probably the particles being partly used up as condensation nucleii.

(*v*) The lowest transparency calculated in the year is 35% in May when $m = 1.5$ in the afternoon due to dust raising winds. The transparency could be lower during dust storms, but measurements cannot be taken in such conditions.

(*vi*) The mean values of turbidity are given in Fig. 3 and isolines drawn in it show similarity to that of transparency in Fig. 1.

(*vii*) β and q should naturally show opposite trends which can be seen in Fig. 4.

(*viii*) The monthly means of diffuse (D) and global solar radiation (G) for days when direct solar radiation has been calculated. The ratio D/G is a measure of scattering, *viz.*, the aerosol content of the atmosphere. This ratio is minimum in winter months increasing gradually towards summer as the atmosphere becomes dusty. With the onset of the monsoon, the values decrease due to the cleaning by washout in the rains. The minimum is in October. During November due to the western disturbances there is an increase in the aerosol content of the atmosphere, which again decreases in December

Since D is a part of G, there is an opinion that $D/(G\text{-}D)$ will represent the scattering better than D/G. This ratio is also given in Fig. 5, which follows exactly the trend of D/G; though the variations are wider.

5. The author is thankful to Shri V. Desikan, Meteorologist of Central Radiation Laboratory, Pune for guidance in the work and useful suggestions and Shri O. Abraham for getting the computations done by preparing a suitable program.

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