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SHORT CONTRIBUTION

Turbidity parameters for the atmosphere over India

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In a recent paper Shirvaikar et al. (1976) have reported a study of the wavelength exponent of aerosol scattering based on Volz Sunphotometer observations made at Bombay for a period of three months mostly under clear sky conditions. The authors have raised some doubts about the accuracy of the values of wavelength exponent α obtained by Rangarajan (1972) based on a quantitative comparison of wavelength exponent α obtained from their measurements in Bombay for the period December 1974 to March 1975 with those obtained by Dr. Rangarajan from measurements in Poona during the year 1970. The conclusions arrived at by Shirvaikar et al. based on this comparison is not quite justified because, firstly, the period of observations at both the stations viz., Poona and Bombay do not coincide and then, although clear skies and good visibility predominate throughout North and Central India during the winter months December to February, the local mist in the morning and frequent haze in the afternoon observed at Poona is sufficient to alter the turbidity parameters when compared with those at Bombay.

In this paper, the author would like to explain certain points regarding the atmospheric turbidity parameters such as the accuracy of wavelength exponent α deduced by pyrheliometric measurements and neutral aerosol attenuation over the Indian subcontinent.

A comprehensive study of the atmospheric turbidity parameters derived from pyrheliometric measurements at a number of stations in India has been made by the author (1971). This study revealed that the thermal instability in the surface layers of the atmosphere and the variability of the moisture content of the atmosphere could be a contributing factor to large temporal and spatial variations of turbidity parameters throughout the year. A seasonal variation in wavelength exponent α often approaching to zero or even negative during the hot summer months was observed. However, the high frequency of negative values of the exponent α was difficult to understand and it appeared probable that the derived amplitudes of the exponent α were somewhat larger than the real ones. With a view to improve the accuracy in the determination of turbidity parameters, a series of careful pyrheliometric measurements were carried out at the Central Observatory, Poona and the turbidity parameters were derived numerically by a procedure outlined by the author elsewhere (1972). It was observed that the turbidity parameters thus derived exhibit variations of much less amplitude which as such are likely to prevail in the case of a real tropical atmosphere. A good proof for the real nature of diurnal turbidity variations was their phase shift with respect to noon; morning and afternoon β-values differ when compared at the same solar elevation. This confirmed that the careful pyrheliometric measurements with properly calibrated filters are self consistent.

In fact, for broad band filter measurements, since the mean values for the wavelength intervals considered for the tabulations of βg, β_{rg} and β_{rr} are relatively close together, i.e. $\lambda_g = 454$ nm, $\lambda_{rg} = 575$ nm and $\lambda_{rr} = 669$ nm, even small errors in β_g, β_{rg} and β_{rr} values derived against different values of air-mass to observed values of intensity of radiation from the nomogram prepared with the help of energy integrals $\int_{0.3}^{0.525} F(\lambda)\,d\lambda$, $\int_{0.525}^{0.630} F(\lambda)\,d\lambda$ and $\int_{0.630}^{0.700} F(\lambda)\,d\lambda$ could result in large variations of the exponent α. This discrepancy can be removed by numerically evaluating the turbidity parameters. The present tendency to use sunphotometers as against pyrheliometers is due to the reason that sunphotometers are less expensive and easy to operate by an observer which makes them convenient for use in close turbidity networks. In principle, the sunphotometers have the advantage of working with homogeneous wavelength groups but, to have meaningful information as regards the transparency of the atmosphere, we need to know how the properties of aerosol affect the integrals over wider wavelength regions and this is achieved by the pyrheliometric measurements of total incident radiation and those measured behind the Schott filters OG1, RG2 and RG8.

As regards the neutral wavelength dependency of haze extinction, it may be mentioned that such cases depend largely on the microphysical and optical characteristics of the atmospheric haze. The negative values of the exponent α, which are mostly associated with various optical phenomena such as Bishop's rings, coloured clouds and milky canopy signify that the aerosol extinction increases rather than decreases with increasing wavelength. This type of scattering behaviour must be due to an aerosol size distribution different from that expressed by Junge's power law. The anomalous haze extinction has also been observed elsewhere by Quenzel (1970) in clear oceanic air and Porch et al. (1971). Porch and his colleagues analysed the observations of the extinction of star light by the atmosphere for nearly forty years and showed that astronomically determined measurements of aerosol extinction are consistent with pyrheliometric measurements. It is well known that there persists a dense pall of dust in the atmosphere over North and Central India throughout the year and more often during the premonsoon months when the visibility is reduced by haze occasionally diminishing to 2 km or less. The souther edge of the haze during the premonsoon season is thought to be about 8° N and was so observed by Bryson & Baerreis (1967) along the Malayan peninsula. While on board a ship which traversed zonally along 20° N during the first phase (May 20–25, 1973) of the joint Indo-U.S.S.R. Arabian Sea Expedition, the author was rather dismayed by the all-pervasive brownish and greyish haze and its extension towards Arabia. A particularly distressing feature was its uniformity and massive extent. Further, the observations of the past twenty or more years have suggested the presence of extremely tenuous cirrus layer at or just below tropopause in tropics which can only be observed visually with slant illumination. Under these conditions of turbid atmosphere, it should not be regarded as uncommon that near zero or even negative values of the wavelength exponent are obtained for Indian region. In general, we observe a definite trend for high (close to unity) values in the monsoon and post-monsoon period and for low (near zero and even negative) values in hot summer months before the outbreak of the monsoon. We often notice that the colour of the sun as it sets (or disappears in strong haze) is white or only slightly citron yellow instead of red. This certainly is in accordance with a generally neutral attenuation.

On the basis of foregoing discussion, it is concluded that we should put more efforts for correct use of pyrheliometric data with recent values of extra-terrestrial spectrum and transmission function of the classical Schott filters and numerically evaluate the turbidity parameters in order to have climatologically useful information on the dust content of the atmosphere.

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