LETTER TO THE EDITOR

Turbidity of the atmosphere over India

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In a number of papers Indian scientists have treated the problem of the dust content of the air above India. The most comprehensive of these papers is the one by Anna Mani, Oommen Chacko and S. Hariharan (1969). The authors have used the measurements within isolated parts of the solar spectrum, obtained by means of the Schott Filters OG1, Rg2 and Rg8. As such filter measurements are carried out at a rather large number of climatological stations, the authors have been able to present a synoptic idea of the turbidity in its dependence on time and geographical position. The changes with time and locality of the two turbidity parameters β and α, of which the former gives an idea of the dust content in the vertical column of air, the latter of the wavelength dependence of the light scattering, are analysed.

For α they find a mean value which in general agrees well with the mean characteristic for most stations at temperate latitudes, namely about 1.0–1.5. The variations, however, are large and in extreme cases, negative values are found. This occurs for instance in many cases when the sky is partly covered by light Ci-clouds. It must be realized, however, that the method used for determining the turbidity parameters (Ångström, 1961, 1963 and 1970) does not exclude the possibility of considerable errors especially from instrumental causes. Even neglect of the effect of the ambient temperature on the filter transmission may thus easily produce deviations in α of about ± 0.3 (Ångström & Drummond, 1959). The average deviation from the mean value at Poona amounts to about ± 0.8 (Mani et al., 1969, table 1).

In a recent investigation reported by S. Rangarajan (1972) the method of pyrheliometric filter measurements for determining the turbidity parameters is replaced by photometer measurements at two separate wavelengths, with application of an instrumental device of Volz described by Flowers et al. (1969). The wavelength intervals measured here are small and can be regarded as perfectly homogeneous.

In the investigation reported on by Mr Rangarajan the wavelengths were $\lambda_b = 0.4010$ μm and $\lambda_r = 0.6005$ with a half width of 30 respectively 20 Å.U. The last named wave length, however, represents a rather unhappy choice. Here the atmospheric ozone has within the Chappuis band a maximum of absorption at 0.600 μm, where the decadic absorption coefficient is as high as 0.067 for 1 cm ozone. Now the ozone content of the atmosphere is known to be rather variable from case to case. A mean value for low latitudes of 0.20–0.25 cm, is reported but the value can easily vary within up to 30 % in individual cases (Foitzik & Hintzpeter, 1958).

In computing aerosol transmission of the named wavelengths regard has been taken to the effect of Rayleigh scattering and ozone absorption, according to information given by the author. But there is no evidence that individual ozone values have been applied in this computation, neither is the reader informed about the depolarization factor used in computing the molecular scattering.

Furthermore, in the computations of Anna Mani et al., the effect of a variable ozone content of the atmosphere may introduce apparent variations in the aerosol transmission, which are not real. But as we are considering here integral radiation values over larger wavelength intervals, given by tables in which a correction is made for mean ozone content, the effect on the results are small and probably in general negligible (Ångström, 1964).

The results of Rangarajan suggest much smaller values for α than those of Anna Mani

et al. It seems rather doubtful, for reasons just given, whether a comparison with earlier values is justified. It seems highly desirable that, when a considerable ozone absorption is affecting the measurements, ozone values for individual days are available and presented.

The discussion of the Indian turbidity measurements brings forth the question concerning the general purpose of the optical studies here concerned. It seems important to distinguish here between two main objects:

I. The measurements aim at a clear understanding of the physical properties of the atmospheric aerosol.

II. The measurements aim at giving a climatological idea about the global distribution of dust in the atmosphere and its influence on the energy exchange between earth and space and at the earth's surface.

For the purpose under I, it is now evident, if we are confined to optical methods, that we need a detailed determination of the scattering and absorption for a great number of wave lengths, as has been accomplished by the spectrobolometric investigations of the Smithsonian Institution (Langley et al.). But as the coefficients derived are dependent also on the *frequency of distribution of particle sizes* within the aerosol, it is, for the purpose given, important that investigations hereof are made parallel with the optical ones. Studies of the kind mentioned must from practical reasons be confined to a few geophysical or astrophysical observatories and it can scarcely be expected that they shall be able to satisfy the demands defined through point II, viz. to give a synoptic idea about the turbidity conditions.

For the last named purpose we must therefore apply technics and methods of a more simplified character. Such a method has been suggested and applied by the present author. The use of the photometric device by Volz seems also, in a practical way, to satisfy the same needs. It has the advantage of working with homogeneous wave length groups, which simplifies the treatment of the observations. But on the other hand this simplification also has its drawbacks. What we need for climatological considerations is not so much information about what happens to a few individual wave lengths, but rather to know how the properties of the aerosol affects the integrals over wider wave length regions. Such wave length regions are those defined for instance by measurements of the total radiation as well as of the radiation passing through filters like RG8, RG2 and OG1.

For climatological studies in connection with long time trends of atmospheric pollution and other effects on the atmosphere such measurements seem of fundamental importance. After almost a century of intense work, the instruments involved in such studies seem now to have reached the stability and accuracy necessary in order to produce results comparable with one another with due regard to time and geographical position.

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