RESULTS OF AEROSOL LASER SOUNDING AS COMPARED WITH AIR HUMIDITY

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ABSTRACT

The complicated relation of optical aerosol characteristics and humidity does not permit so far to give a single-valued answer to the problem on the connection of the scattering coefficient σ with the relative air humidity q .

Theoretically this problem was investigated by Hanel, Ref.[1]. In the assumption of the condensing mechanism of particle size growth for $40\% \leq q \leq 99.9\%$ he obtained the equation

$$\frac{\sigma(q)}{\sigma(q_0)} = \left(\frac{1-q_0}{1-q}\right)^{2\varepsilon} \qquad (1)$$

where $\sigma(q)$ is the scattering coefficient value at the humidity q , q_0 is the reference humidity at a certain altitude chosen arbitrarily, $\varepsilon \simeq 0.5$ and depends on the type of aerosol.

Eq.(1) is of interest from the point of view of a possibility to estimate the humidity profile according to the aerosol scattering profile measured. Some results of laser sounding carried out in summer 1972 in the conditions of the large

industrial center and in winter 1973 far from the town were evaluated for this purpose.

The humidity profiles σ and the function $Q(z)=\left(\frac{1-q(z)}{1-q(z_0)}\right)$ being the right part of Eq.(1) were analyzed.

An analysis of the results of the natural aerosol sounding in winter 1973 has shown that at humidities between 70 and 95% Eq.(1) is properly fulfilled, 2ε being close to 1. In the case of lower humidities the relation between σ and Q is deteriorated, in this case the "hysteresis" is observed that is developed in the lag of the scattering coefficient decrease behind the humidity drop. It is accounted for Eq.(1) being obtained in the assumption of the condensing mechanism of particle size variation. Meanwhile in Ref.[2] it is shown that at the humidity being less than 60% the coagulating character of the particle size increase often prevails, with the humidity increase, the humidity decrease does not lead to the instantaneous decrease of the scattering coefficient since the particle disintegration into smaller ones is less probable than their coagulation.

The summer measurements in the industrial center do not allow to connect σ and q with Eq.(1). In the conditions of the industrial center when there are many pollution sources the atmosphere turbidity can be more influenced by other factors than the humidity:temperature inversion, air stream distribution, ground layer turbulence, etc.

In addition to the above said the humidity can differently influence the scattering aerosol properties.

A comparison of the humidity with the microphysical aerosol parameters, obtained with an electron microscope, allowed two

competitive processes to be separated out. One of those, i.e., the coagulation resulted in the reduction of the calculating concentrations of solid particles, another results in the appearance of specific particles of sizes between some hundredth to two-three tenth microns. It seems more probable that these are hygroscopic particles of photochemical origin, i.e., sulfates and complex systems of minute particles with sulphuric acid or water in the space between them. These particles account for the atmosphere turbidity increase with the humidity increase, but they are not connected with it uniquely since they evidently depend also on the concentration of sulfur compounds.

The experiments carried out allowed preliminary conclusions reguiring refinement to be drawn.

1) For natural aerosols with the humidity between 70 and 95% there is a definite relation between the humidity and the scattering coefficient. In accordance with one reference humidity value it is possible to predict satisfactorily its profile following the data of laser sounding of the aerosol profile.

2) In the simultaneous presence of the aerosol profile and humidity profile one can conclude about the aerosol homogeneity in the atmosphere region being sounded.

3) For the aerosols of industrial origin there is no single-valued connection between the humidity and the scattering coefficient. At humidities up to 70–80% the coagulating processes prevail and the applicability of Eq.(1) is doubtful.

REFERENCES

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