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MULTI-WAVELENGTH LASER SOUNDING OF THE TROPOSPHERE OVER CONTINENTAL REGIONS

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The observations of the wavelength dependence of aerosol optical parameters in the troposphere over continental regions have been made by the groundbased multi-wavelength lidar systems. The motivation behind these observations is primarily to develop the regional optical atmosphere models. The obtained data will enable one to make radiative transfer calculations for the atmosphere more accurate, to improve atmosphere correction methods in observing the Earth from satellites and aircrafts.

The measurements were implemented by the multi-wavelength lidars "Glory" and "Glory-M" whose transmitters are formed by dye lasers. Two sets of simultaneous pulses are produced by the lidars to probe the atmosphere, each a set being at four wavelengths. Since the one and the other set of pulses have as the same the wavelength 0.694μm due to the Ruby pumping laser, the total conjunction of the emitted pulses employs actually seven wavelengths for sounding. These wavelengths are within the range 0.38 - 0.96μm.

The long-term experimental practice provided aerosol parameter data pertinent to diverse geophysical conditions. For the present discussion we took the data obtained in the middle latitudes in the regions not susceptible to immediate industrial polluting. These regions can be classified as the continental country ones by their atmosphere aerosol composition. Concretely, the observations were made at the Biospherical Background Station of the northwest area of Belarus as well as to north of Minsk (Belarus) and at the meteorological station in Obninsk (Russia). The findings were enhanced by meteorological parameters independently measured. Also, for some occasions, determining of the atmosphere optical depth and aerosol sampling were carried out.

In the present work the wavelength dependence of aerosol extinction vertical profiles are dealt with. Due to a large body of obtained experimental information the statistical treatment was allowed. We sought to investigate profiles of the mean aerosol extinction as well as to perform the correlation analysis respecting to extinction coefficient values. After we have processed the obtained data in a fashion described in Ref.1. We have got an opportunity to compare our experimental results with the calculations based on the atmosphere models SRA-84 presented by Ref.2. The following brief conclusions generalize the results of the pursued investigation.

1. The profiles of the mean aerosol extinction $<\varepsilon(h)>$ show enhanced turbidity of the boundary layer. Within this layer a form of the profiles fit the model CONT-1 (SRA-84) satisfactorily (Fig.1).

2. For the mean aerosol extinction spectra the power law approximation is fairly good of the form $S(\lambda,h_i)=<\varepsilon(\lambda,h_i)>=C\lambda^{-\nu}$, where C and ν are found parameters. For the boundary layer, the parameter ν height dependence appears to be rather weak and the parameter ν takes values from 0.9 to 1 over diverse regions. For the upper troposphere, the increase of the value ν up to 1.25 - 1.27 is brought out. This doesn't fit the model CONT-1, which requires the value ν be constant within the entire troposphere layer. To overcome this discrepancy

between the experimental results and the model it is enough to correct the model by acceptance of that the relative content of aerosol fractions is different in the lower and upper layers of the troposphere.

3. Strong correlation of the aerosol extinction coefficient within the spectral range of concern emerged in calculation of the covariance matrix $W_\varepsilon(\lambda_i,\lambda_j) = <\varepsilon(\lambda_i)\varepsilon(\lambda_j)>$. It is followed from this, a few-parametric model can be built for the function $S(\lambda, h_i)$ by employing the technique of random vector expansion in the natural orthogonal components. This $S(\lambda, h_i)$ can be reconstructed with a few wavelengths to a predefined probable error.

4. We infer from the analysis of the obtained data massive that changes in the extinction coefficients are correlated within either the boundary layer or the layer above 2km. The correlation between these two layers has not been revealed. The Fig.1 depicts the vertical distribution of the correlation radius. It is seen, unstability of atmospheric optical parameters appears within the transition layer at heights about 2km.

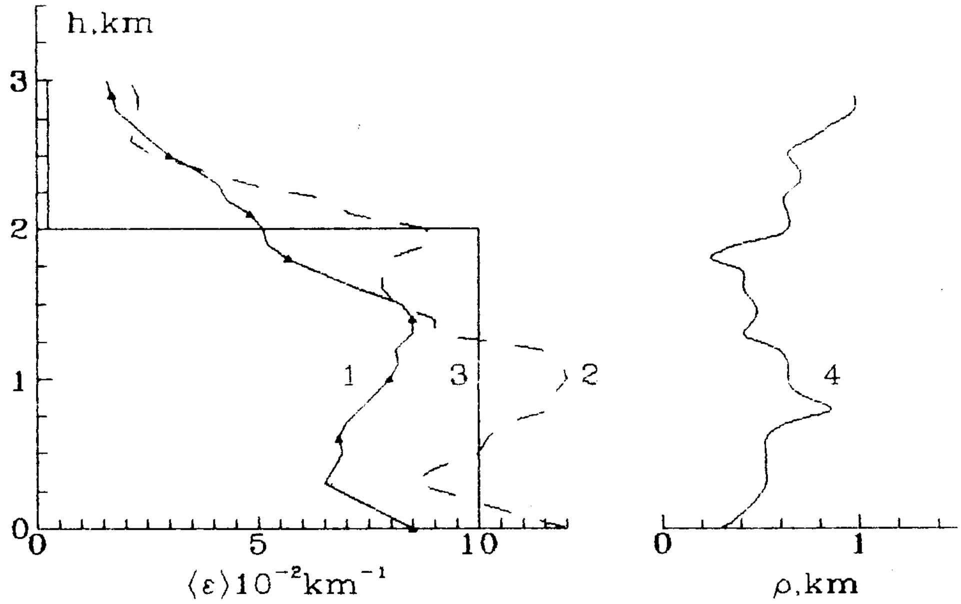

Fig.1 The profiles of the mean aerosol extinction (1-3) (λ=0.694 μm) and the correlation radius (4); 1 - at the Biospherical Background Station; 2 - at the Station to north of Minsk; 3 - the model CONT-1.

References

1. A.P. Chaikovsky, V.N. Shcherbakov, S.B. Tauroginskaya. Technique for determining atmospheric aerosol optical parameters by multi-wavelength laser sounding (in the proceeding of the present Symposium).

2. A preliminary cloudless standard atmosphere for radiation computation. International Association for Meteorology and Atmospheric Physics Radiation Commission. Boulder, Colorado, U.S.A. 1984. 53 p.