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Laser Radar System for Control of Aerosol Pollution from a Power Plant

Tsvetan Mitsev[1], Erwin Ferdinandov[2], Georgi Kolarov[3] and Ivan Grigorov[4]

Abstract – **In the following research we have shown the results from measuring the aerosol pollution concentration over Sofia city. We have used Light Detecting and Raging system with high repeating frequency of the impulses (signals) equipped with a copper vapor laser (λ = 510,6 nm). The receiver system counts the photons. We have evaluated the remote dependency of the measuring error.**

Keywords – **Lidar, Remote Sounding, Aerosol Pollution.**

I. Introduction

Lidar systems are a powerful and unique method for conducting an extensive remote research of a number of physical phenomena in the atmosphere, which are connected to the 3-D distribution and the time dynamics of its aerosol contents.

Scanning lidars for ecological monitoring of the aerosol pollution over industrial centers and urban systems have an especially broad practical implementation.

Our research presents the application of an invented in the Institute of Electronics of the Bulgarian Academy of Sciences lidar for measuring and quantity controlling of the aerosol pollution over the city of Sofia. It is shown that the mass concentration of pollution over various regions of Sofia depends on their location in comparison with the dominant, at the time of measuring, aerosol source and on the meteorological parameters.

II. Methodics

For computing the remote profile $M(z_i)$ of the mass aerosol concentration on the sounding path we use the algorithm suggested by Klett [1]:

$$M(z_i) = K_1 \frac{S(z_i)}{\dfrac{S(z_k)}{\alpha(z_k)} + 2\Delta z \sum_{j=i+1}^{k} S(z_i)} + K_2 \,, \qquad (1)$$

[1] Tsvetan Mitsev is with the Faculty of Communication Technics and Technologies, Kliment Ohridski blvd. 8, 1797 Sofia, Bulgaria, E-mail:Mitzev@vmei.acad.bg.

[2] Erwin Ferdinandov is with the Faculty of Communication Technics and Technologies, Kliment Ohridski blvd. 8, 1797 Sofia, Bulgaria.

[3] Georgi Kolarov is with the Institute of Electronics – Bulgarian Academy of Sciences, Tzarigradsko Shaussee blvd. 72, 1784 Sofia, Bulgaria, E-mail:kolarov@ie.bas.bg.

[4] Ivan Grigorov is with the Institute of Electronics – Bulgarian Academy of Sciences, Tzarigradsko Shaussee blvd. 72, 1784 Sofia, Bulgaria, E-mail:ivangr@ie.bas.bg.

where $i \in [1, k-1]$ is the number of the remote interval on the measurement path situated at a distance z_i from the lidar (the path is divided into k intervals with a length of Δz), $S(z_i)$ is the multiplied by z_i^2 lidar signal, $\alpha(z_k)$ is the volume coefficient of the aerosol extinction in the point of "tying" of the solution, K_1 and K_2 are constants, determined on the basis of conventional measurements.

The remote profiles of the systematic and random errors of the measurements are computed on the basis of the proposed by us methodics [2].

III. Lidar System

The block scheme of the lidar is shown in Fig. 1.

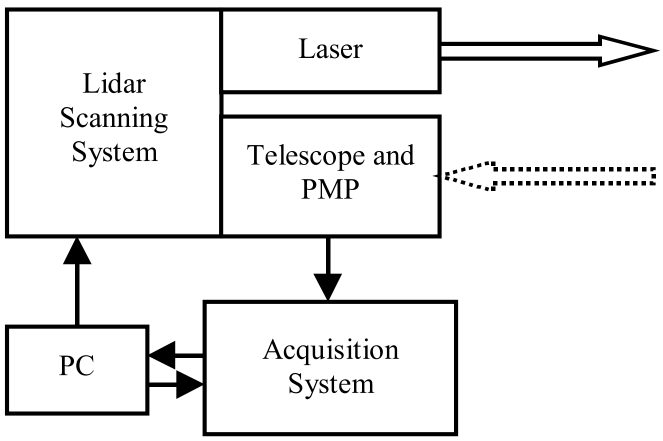

Fig. 1. Block scheme of the lidar

A more complete description of the lidar system including its full technical characteristics is given in [3].

IV. Experimental Results

A graph of the measurement paths' locations is shown in Fig. 2.

The measured remote mean profiles of mass concentration of the atmospheric aerosol are graphically shown in Fig. 3. The lidar data are from 20:00 h to 22:30 h on 26 Oct., 2001.

V. Conclusion

The relatively strong shifts of M on Path 1 are due to the distributed throughout Sofia's territory sources of aerosol pollutions with different intensity.

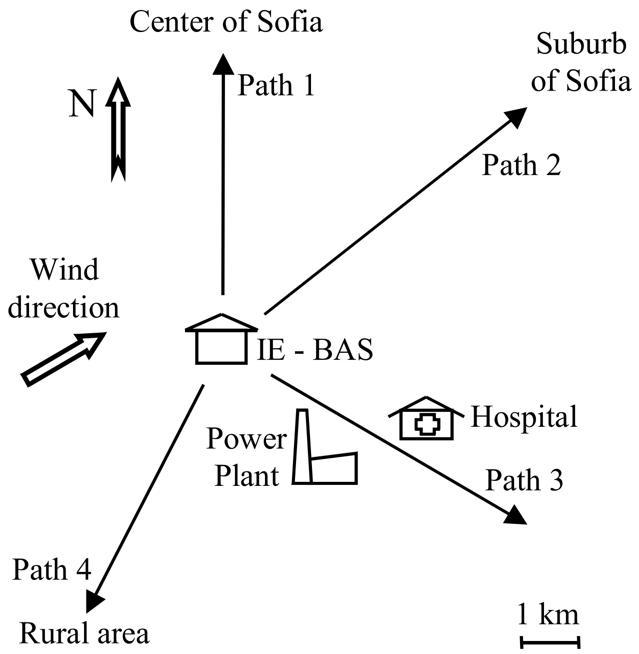

Fig. 2. Location of the measurement paths and the power plant

Relatively cleaner air is over the suburb of Sofia shown by Path 2.

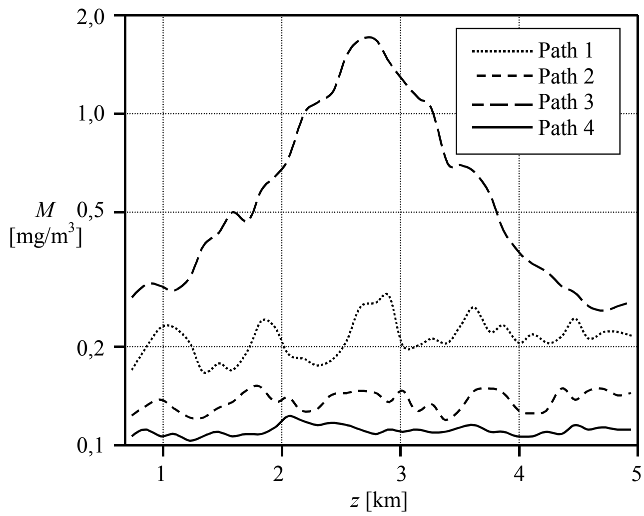

Fig. 3. Remote profiles of mass aerosol concentration

Particularly high M values are on Path 3, which passes near a powerful source of aerosol pollution – Power Plant "Drujba" (Fig. 2). The clearly expressed high maximum of $z \approx 2{,}7$ km is conditioned by the aerosol spread which crosses Path 3 under the influence of the wind. That fact is alarming because a hospital is situated under the aerosol spread (see Fig. 2).

The lowest mass aerosol concentration is, as expected, over the rural area, under Path 4.

In Fig. 4 are depicted the computed remote dependencies of the systematic and random errors, respectively E_M и ε_M, that accompany lidar measuring.

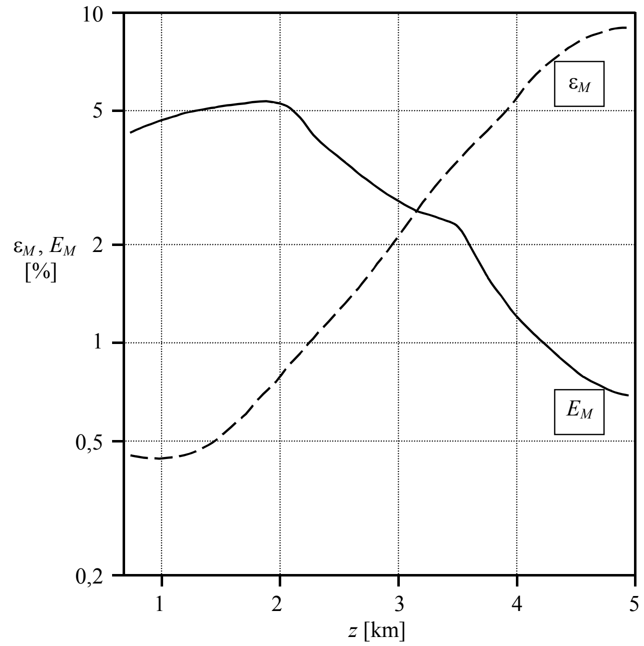

Fig. 4. Remote profiles of the systematic and random errors

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