

GROUND REMOTE SENSING OF BACKGROUND AIR POLLUTION LAYER ON THE CITY OF BAKU BY THE DAY SKY BRIGHTNESS

F.I. ISMAILOV

*Azerbaijan National Aerospace Agency Institute of Ecology
370106 Baku, Azerbaijan, 159*

Remote sounding of air pollution by scattered sun light has proved to be useful for analysis background level in conditions of the city smoke. This paper deals with the investigation of the space characteristics of altitude air pollution layer on Baku from the day sky light measurements.

Introduction

The background air pollution layer in conditions of Baku smoke has been formed during many years. Study of modern state of this layer is one of the cardinal problems of ecological monitoring of background level of anthropogenic impact on all Absheron Peninsula.

It is known that the intensity of background air pollutions is determined by the number of background aerosol particles which are very optically active at effective wavelength $\lambda=0.55\mu\text{m}$ of solar radiation [1-3]. Ground remote sensing of air pollution by incoming solar radiation is of great interest. This method is very informative and technically simple [2, 3].

The present work includes the information about the results of research of space situated and different characteristics of background air pollution layer on Baku from the day sky light measurements which carried out with actinophotometric device [4].

Methods of the research and results

The day sky light brightness depends on changes of optical depth τ and scattering functions $f(\theta)$ of background aerosol particles; where θ is the scattering angle [2, 3]. The determination of these parameters is based on measurements of illumination of direct radiation S and the sky brightness $B(\theta)$ in solar almucantar for any time:

$$\tau = \ln P = \frac{1}{m_0} S / S_0 \tag{1}$$

$$f(\theta) = \frac{1}{m_0} B(\theta) / S_0 \tag{2}$$

where S_0 is the solar constant, P is the atmosphere transmittance, m_0 is the optic mass of atmosphere.

The scattering angle is determined according to formula [2]:

$$\cos\theta = \cos Z \cos Z_0 + \sin Z \cdot \sin Z_0 \cdot \cos\phi \tag{3}$$

where Z_0 is the solar zenith angle, Z is the sensing zenith angle, ϕ is the sensing azimuth angle.

The background level of air pollution can be estimated from the following empirical expression [3]

$$\nu = 2,2 \cdot 10^{-11} \cdot \sigma \tag{4}$$

where ν is the volume concentration of background aerosol, σ is the scattering coefficient at wavelength $\lambda=0.55\mu\text{m}$.

Experiment has been carried out on the actinophotometer [4] which were constructed specially for research of atmospheric transparency. Figure 1 shows the medium Bouger curves for the west and east of Baku. These curves derived from observations data by Bouger – Lambert long method [2] and averaged over the period from the sunrise to the afternoon (curve 1) or from the afternoon to the sunset (curve 2).

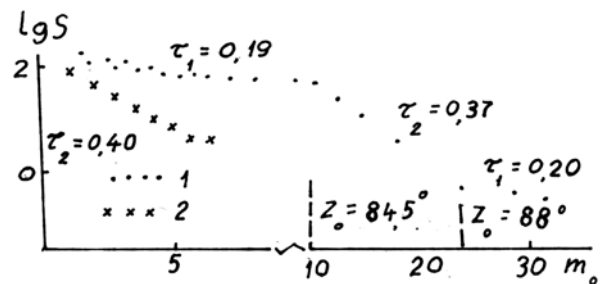


Fig.1. Medium Bouger curves for observed points:
1 - Mushvigabad settlement; 2 - Ahmadli settlement.
 τ - optical thickness in directions to the pollution layer

(τ_2) and in other directions (τ_1) in $\frac{w}{m^2 \cdot sr \cdot pm}$.

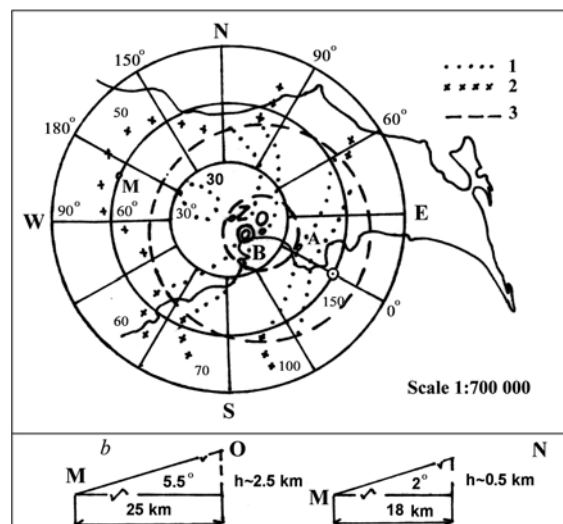


Fig.2 a) medium isophots of day sky (August, 2002) 1 - in region (3) of pollution layer, 2 - out of this region, M – Mushvigabad, A - Ahmadli, Z - zenith, O - center of pollution layer, B - Baku. b) h_2 - upper and h_1 - low altitude of boundaries of pollution layer.

As seen from figure 1 the Bouger curves in the region $m_0=10\div 29$ have been observed the “anomaly” which apparently is connected with the background pollution layer. Therefore, dependence of optic thickness from relative air mass can apply to study background air pollution on city in detail.

The angular dependence of the scattered sky light are shown on the figure 2. This dependence is represented by day sky light measurements in different almucantars and verticals on territory of the institute of Ecology.

The results of measurements were graphed in the form of maps of the radiance on sky sphere. Figure 2a show high values for the forward scattering directions from zenith to horizon, a minimum at the scattering angle about $(Z=20^\circ, \Phi=180^\circ)$ and slightly increasing values towards

the backscatter azimuth angle of 180° . This behavior is typical for background aerosol scattering.

Angular dependence of diffuse light from the day sky contains information about the geometry of distribution of background air pollution layer. For estimate space size of this layer we determine relative values of the scattered solar radiation in different angles region $(\theta_i, \theta_i - \pi/6)$ as follows:

$$I_i = \int_{\theta_i - \Delta\theta_i}^{\theta_i} f(\theta) \sin\theta d\theta \bigg/ \int_0^\pi f(\theta) \sin\theta d\theta \quad (5)$$

In table 1 there have been presented values of ratio the (5) for $\Delta\theta = \pi/6$ and $i=1\div 6$.

Values of quantity (5) in per cent (%)

θ_i in degrees	30	60	90	120	150	180	- 30	- 60	- 90	- 120	- 150	- 180
I_i , in %	13	10	9	7	5	4	13	11	10	6	6	4

As it is seen from table 1 isophots have very asymmetric structure on direction perpendicular to the solar vertical. Figure 2a shows that the center of pollution layer is observed at point 0 with the spherical coordinates about $z=22,5^\circ, \Phi=-5^\circ$.

It was impossible to evaluate altitude propagation of air pollution layer. In the following figure 2b it has been found altitudes of upper and low boundary of pollution layer for angles of view (figure 1) and distances on the earth (figure 2a) from observed point M.

Values of average parameters of air pollution layer on Baku are given in table 2.

Conclusion

1. The day sky brightness and direct solar radiation measurements were carried out with actinophotometric device [4] in conditions of Baku smoke. It is found that the strongly background air pollution layer on Baku have place.

2. The results of calculations of mean characteristics of background air pollution layer are given.

3. It is shown that the method of ground remote sensing of air pollution layer by the incoming solar radiation may be

used to receive the most capacious information in conditions of the city smoke in view of their regularity.

Characteristics of background air pollution layer on Baku.

Parameter	Value
Thickness	$\Delta h = h_2 - h_1 = 2 \text{ km}$
Radius of cross section	$R = 17 \text{ km}$
Space volume	$V = \pi R^2 \cdot \Delta h = 1,8 \cdot 10^3 \text{ km}^3$
Optical thickness	$\Delta\tau = \tau_2 - \tau_1 = 0,2$
Optical density (scattering coefficient)	$\nu = \frac{\Delta\tau}{\Delta h} = 0,1 \text{ km}^{-1}$
Volume concentration	$\nu = 2,2 \cdot 10^{-11}$
Mass concentration (density of particles $p = 2 \text{ g/sm}^3$ [3])	$M = p \cdot V = 44 \frac{\text{mg}}{\text{m}^3}$
Mass of layer's pollution	$m = M \cdot \nu = 80t$

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F.I. İsmayılov

BAKI ŞƏHƏRİ ÜZƏRİNDƏ HAVANIN FON ÇİRKƏNMƏSİ QATININ SƏMANIN GÜNDÜZ PARLAQLIĞINA ƏSASƏN YER ÜSTÜ MƏSAFƏDƏN TƏDQIQI

Böyük sənaye şəhəri şəraitində fon səviyyəsinin analizi üçün Günəşin səpələnən şüalanmasına əsasən havanın çirklənməsinin məsafəli öyrənilməsi faydalı olduğu aşkar edilir. İşdə Bakı şəhəri üzərində səmanın gündüz işığına əsasən havanın çirklənməsinin yüksək qatının fəza xüsusiyyətləri öyrənilir.

Ф.И. Исмаилов

**НАЗЕМНОЕ ДИСТАНЦИОННОЕ ИССЛЕДОВАНИЕ ФОНОВОГО СЛОЯ ЗАГРЯЗНЕНИЯ
ВОЗДУХА НАД ГОРОДОМ БАКУ ПО ЯРКОСТИ ДНЕВНОГО НЕБА**

Дистанционное зондирование загрязнения воздуха по рассеянному излучению Солнца является важным для анализа фоновых уровней в условиях крупного промышленного города. В работе исследуются пространственные характеристики высотного слоя загрязнения воздуха над городом Баку по измерениям света дневного неба.

Received: 19.05.03