

SELECTION OF CLOUDS ON THE BACKGROUND OF AN UNDERLYING SURFACE
BY THE CHARACTERISTICS OF REFLECTED LASER SIGNALS

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ABSTRACT

For satellite meteorology weather forecast a feasibility of the determination of cloud phase state and density, as well as cloud selection on the background of an underlying surface by the characteristics of air-borne lasers reflected radiation is rather promising.

The basic characteristics of the reflected radiation are as follows: polarization rate ρ , pulse deformation, in particular, pulse broadening η , as well as back and volume scattering coefficients σ_{π} and σ accordingly. Measurements of these characteristics were conducted in various regions of the USSR by means of an air-borne ruby lidar with the radiation polarization rate $\rho = 1$. The results of such measurements are given in Table 1 where types of objects and limits of the variation of ρ , η , σ_{π} , and σ are indicated. Depolarization of the radiation, i.e. a decrease of ρ values caused by cloud scattering is due to non-sphericity of particles and multiple scattering. In case of scattering in droplet clouds signal depolarization is caused by multiple scattering alone, while in crystal clouds a decrease of ρ is due to both factors. The depolarization of signals reflected from underlying surfaces is caused by the roughness of these surfaces. The pulse broadening η and ρ decrease with a cloud density increase. The roughness of the surface causes pulse broadening as well. The values of σ_{π} for clouds differ rather significantly from those for underlying surfaces. Thus the tabulated values of ρ , η , σ_{π} , and σ give us ground to assume that by these characteristics of reflected laser radiation one can determine cloud phase state, cloud density within the limits of the penetration of a sounding beam into a cloud, and select clouds on the background of all types of underlying surfaces. Besides, it is possible to distinguish sea from land by these characteristics from board an aircraft. It should be noted that in Table 1 the dimensionless reflection coefficient σ_{π} for underlying surfaces is given in place of ρ .

Table 1.

Type of re- flecting object	Polariza- tion rate ρ	Pulse broad- ening η	Backscattering coefficient $\sigma_{\pi} \text{ m}^{-1}$	Volume scat- tering coef- ficient $\sigma \text{ m}^{-1}$
Droplet clouds	0.84 - 0.86	3.4 - 4.2	$2.4 \cdot 10^{-4} - 4.9 \cdot 10^{-4}$	0.01 - 0.022
St	0.61 - 0.76	2.4 - 2.8	$7.2 \cdot 10^{-4} - 1.2 \cdot 10^{-3}$	0.03 - 0.055
	0.48 - 0.68	1.7 - 2.5	$1.4 \cdot 10^{-3} - 2.2 \cdot 10^{-3}$	0.06 - 0.09
Sc	0.81 - 0.88	3.2 - 4.1	$2.3 \cdot 10^{-4} - 6.8 \cdot 10^{-4}$	0.01 - 0.03
	0.46 - 0.64	1.7 - 2.4	$1.1 \cdot 10^{-3} - 2.3 \cdot 10^{-3}$	0.05 - 0.09
Ns	0.54 - 0.71	1.6 - 3.5	$4.6 \cdot 10^{-4} - 2 \cdot 10^{-3}$	0.02 - 0.08
Crystal clouds	0.1 - 0.23	1.8 - 2.7	$1.5 \cdot 10^{-3} - 4.2 \cdot 10^{-3}$	0.05 - 0.09
Mixed clouds	0.3 - 0.5	1.6 - 2.9	$6.5 \cdot 10^{-4} - 3.6 \cdot 10^{-3}$	0.03 - 0.09
Sea	0.6 - 0.9	1.0 - 1.1	0.03 - 0.25	
Desert	0.1 - 0.45	1.0 - 1.4	0.03 - 0.12	
Sand	0.08 - 0.4	1.0 - 1.2	0.12 - 0.45	
Steppe	0.2 - 0.34	1.0 - 1.1	0.06 - 0.16	
Snow	0.1 - 0.4	1.0 - 1.3	0.15 - 0.6	