APPLICATION POLARIZATION METHODS FOR INCREASE OF ACCURACY OF MEASUREMENTS IN PROBLEMS OF REMOTE SENSING

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At remote sensing of a environment and determination of its characteristics always there is a problem of minimization of influence of such factors, which are not connected to these characteristics, but which by a essential image has influence on measuring signals. To these factors, for example, inclinations of a flying vehicle, chopiness of a marine surface, small-sized roughness of topsoil and etc. In this connection there is a problem on development of the appropriate recommendations at realization of measurements. In particular, the influence of the listed factors canessentially be reduced by choice of a certain kind of polarization of radiationelectromagnetic wave.

In overwhelming majority cases at polarization measurements are used two orthogonal linear polarizations, in particular horizontal and vertical. Thus, maximally possible number independent polarization's measurements equally two and all information on the characteristics of a surface is contained in measured factors of reflection on vertical R_V and horizontal R_H polarizations.

Availability of roughness on a surface results in change of reflection coefficient on both types of polarization in comparison with reflection coefficient of radiowave from a smooth surface R_{VS} and R_{HS} with same dielectric permitivity ε and at the same corner of supervision α.

Thus, the information about roughness of a surface is contained only in sizes $\Delta R_V = R_{VS} - R_V$ and $\Delta R_H = R_{HS} - R_H$. In this connection natural the introduction of special parameter S, dependent only from ΔR_V and ΔR_H is represented, which will represent itself as a measure of roughness.

If modules of reflection coefficient on vertical and horizontal polarizations are known, it is possible find phases of reflection coefficients, and on it to determine complex dielectric permitivity from parities:

$$\begin{cases} \varepsilon = \left(\dfrac{1+R_H}{1-R_H}\cos\alpha\right)^2 + \sin^2\alpha \\ \varepsilon = \dfrac{1+\sqrt{1-\left(\dfrac{1-R_V}{1+R_V}\right)^2 \sin^2 2\alpha}}{2\left(\dfrac{1-R_V}{1+R_V}\right)^2 \cos^2\alpha} \end{cases} \qquad (1)$$

Using a parity: $R_{\Gamma} = R_H \frac{R_H + \cos 2\alpha}{1 + R_H \cos 2\alpha}$, it is possible to show, that parameter $S = \frac{R_H}{R_{\Gamma}}$ for roughness of a surface is equal:

$$S = \frac{1 - R_H^2}{2\left(1 - R_H^2\right) - 2\left(R_H^2 - R_{\Gamma}^2\right)R_H \cos 2\alpha - \left(1 - R_{\Gamma}^2\right)\left(1 + R_H^2 \cos^2 2\alpha\right)}, \qquad (2)$$

where R_H *and* R_{Γ} ( ) - reflection coefficient of radiowaves on horizontal and vertical polarizations from of a roughness surface.

The coefficient S varies at transition from a smooth surface to roughness by monotony.

Let the model of a eratical surface represents set of cones on a plane, the corner in the basis of which is constant or distributed under the normal law. If to enter a average corner in the basis of cones $\varphi_0 = \overline{\varphi}_i$, then $a^2 = \frac{4\sigma^2}{l^2} - \tan^2 \varphi_0$, where σ^2 - dispersion of deviations of a surface, l- radius of space correlation, φ_i- corner of a inclination of a surface.

To more eratical surface there correspondsa greater corner φ_0 and the unequivocal dependence S from φ_0 means unequivocal dependence S from a^2. We shall notice, that dielectric permitivity is supposed a surface constant for all φ_0, since $S = S(\varepsilon, \varphi_0)$. The significance a^2 depends only on a geometry of a surface. Increase φ_0 results in a increase of reflection coefficient on vertical polarization in comparison with case of supervision of a flat surface under the same corner of supervision and about to such to reduction of reflection coefficient on horizontal polarization. The minimum significance S_{min} is reached at $R_H = R_{\Gamma} = R_0$. It equally

$$S_{min} = \left(1 - R_0^2\right)\left(1 - R_0^2 \cos^2 2\alpha\right)^{-1}. \qquad (3)$$

The range of change S lies in limits $S_{min} \le S \le 1$. The degree of roughness can be characterized also by value S_1, possible change representing by share maximally S at constant significance of dielectric permitivity: $S_1 = \frac{1 - S}{1 - S_{min}}$.

It is in this case necessary to know value S_{min}, determined through R_0 at the help of the formula (3). As a factor R_0 it is possible to take its significance, received at vertical supervision. The advantage S_1 of in comparison with S consists that first is weak depends from dielectric permitivity of a surface and is, thus, characteristic of its form.

Let us show the entered characteristics Let on a example of model of an eratical surface,presenting set of cones on planes. We shall again consider case of a constant corner in the basis of a cone φ_0 and case, when this corner is distributed under the normal law with $\sigma = 5^0;10^0;15^0$. We shall accept average significance of a corner to equal significance $10^0;15^0;20^0$.

Dependence of S from a corner sighting at various corners in the basis of cones, dielectric permitivity and dispersion are indicated on fig. 1. It is whence visible, that the influence of roughness on S grows at a increase of a corner of supervision. To large significances of dielectric permitivity there corresponds a greater range of change of S. It should note, that dispersion of a corner in the basis of cones does not practically render influence to S_1, significance of which, thus, is determined by a average corner in the basis of cones.

Knowing the significance ε and S can with a high degree of accuracy be determined average significance of a corner φ_0.

The entered quantitative degree of roughness S can be also used for determination of dielectric permitivity of roughness surfaces to polarization measurements.

For exact determination of dielectric permitivity it is necessary to know of reflection coefficient R_{VS} and R_{HS} for a flat surface.

In practice determination of reflection coefficient of a roughness surface on vertical R_V and horizontal R_H polarization occurs. Obviously, that if differences $\Delta R_V = R_{VS} - R_V$ and $\Delta R_H = R_{HS} - R_H$ are known, it is possible find significances R_{VS} and R_{HS}, reflections appropriate to factors of a flat surface with same dielectric permitivity. Use of these values in accounts gives more exact significance dielectric permitivity.

The essential influence to accuracy of polarization methods of determination of parameters renders choice of corners of supervision. At the same time at supervision of a eratical surface from a plane the corners of supervision do not remain constant, changing, for example, at supervision conic mountain from significances of corner $(\theta - \varphi_i)$ up to $(\theta + \varphi_i)$ (θ - corner of supervision). The problem, as a rule, consists in a finding of a corner of supervision, optimum in the sense that for particular рельефа average significance of a corner of supervision equally required.

We shall consider a delivered problem with reference to a single grie, which we shall consider as a cone, we and then shall generalize results on case of a surface, presenting set of cones of various height.

For a corner of supervision θ the average significance $\overline{\cos\alpha}$ is as follows:

$$\overline{\cos\alpha} = \left[\int_S (\vec{n},\vec{\theta})\cos\alpha\, dS_c\right]\left[\int_S (\vec{n},\vec{\theta})\, dS_c\right]^{-1}. \qquad (4)$$

From the formula (4) it is possible to receive:

$$\cos\theta = \frac{1}{2\pi}\left[\pi\overline{\cos\alpha} - \sqrt{\pi\cos^2\varphi_i\left[\pi\left(\overline{\cos\alpha}\right)^2 - 2\sin^2\varphi_i\right]\sin^4\varphi_i\sec^2\varphi_i\csc^2\varphi_i}\right] \qquad (5)$$

The dependence of a corner of supervision on a sighting corner at various corners φ_i is indicated on fig. 2.

Analysis shows, that for increase of reliability of measurements it should reduce a sighting corner. Thus a little accuracy of determination of required parameters will decrease, but share of measurements, ensuring about by equal accuracy will increase. For increaseof reliability of polarization measurements it should be set by a minimum sighting corner and on it to determine a corner of supervision from (5).

At summarising of received results on case of a surface, presenting set of cones of various height, we receive practically similar conclusions.

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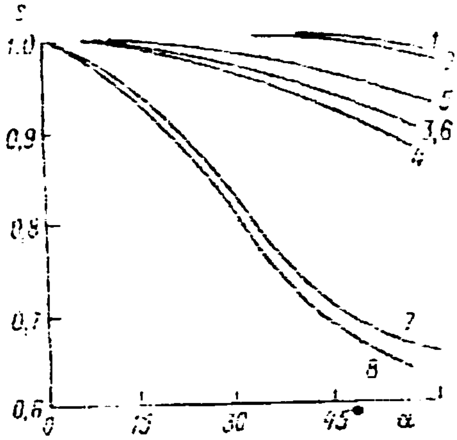

1.0
0,9
0,8
0,7
0,6
0
15
30
45°
α
1
2
5
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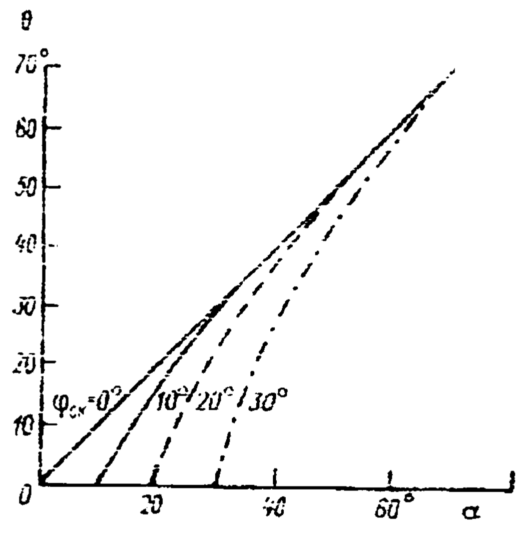
8



θ
70°
60
50
40
30
20
10
0
20
40
60°
α
φ_{cx}=0°
10°
20°
30°