

ABSTRACTS OF PAPERS ACCEPTED FOR THE SYMPOSIUM BUT NOT PRESENTED

ON SOME ASPECTS OF THE INTERACTION OF THE PULSE AND THE MEDIUM DURING THE VERTICAL ECHO SOUNDING OF GLACIERS

By G. V. TREPOV, B. A. FEDOROV and G. P. KHOKHLOV

(Arkticheskiy i Antarkticheskiy Nauchno-Issledovatel'skiy Institut, Fontanka 34, Leningrad
D104, U.S.S.R.)

ABSTRACT. The paper discusses three aspects of the interaction of a radar pulse and the medium which is being sounded, that is the glacier proper and the lower scattering surface. These aspects are:

1. Radar signals attenuation during vertical sounding.
2. The rate of radar signal propagation through the glacier.
3. Fluctuations of radar signals during horizontal movements.

Representative samples of signal attenuation were chosen for two points in the vicinity of Mirny station in Antarctica, these samples were obtained under roughly constant temperature conditions of the ice. The scattering properties of the bedrock are shown to be the controlling factor. Histograms of attenuation for these two points are given; effective temperatures of the ice were estimated.

The measurements of the propagation velocity of electromagnetic waves were made along paths near "Molodezhnaya" station. Interesting results were obtained. The curves of the variation of the amplitude of reflected pulses were obtained for a number of short-distance paths with the radar moving horizontally, the working radar frequencies were 60, 213 and 440 MHz. Radii of autocorrelation of signal fluctuations were estimated. The fluctuation pattern along each of the paths is shown to be stable in time provided the distance is short enough. Measurement of the surface velocity of ice sheet movement by the transition of the fluctuation pattern in time seems quite promising.

POLARIZATION CHANGES OF RADIO SIGNALS IN VERTICAL RADIO-ECHO SOUNDING OF GLACIERS

By V. V. BOGORODSKIY, G. V. TREPOV and B. A. FEDOROV

(Arkticheskiy i Antarkticheskiy Nauchno-Issledovatel'skiy Institut, Fontanka 34, Leningrad
D104, U.S.S.R.)

ABSTRACT. An electromagnetic linearly-polarized signal transmitted through the glacier in a vertical direction, reflected from the bedrock, and received with a receiving antenna, is found to be changed into one either partially or elliptically polarized. The polarization changes are believed to be due mainly to the crystal structure of the glacier and anisotropy caused by the pressure of the upper layers.

An analysis of the polarization diagrams obtained is up to the present the main method used for studies of the reflected signal polarization. Evidently using a simple dipole a partially polarized signal is not distinguishable from one that is elliptically polarized, nor is a non-polarized signal distinguished from circularly polarized. However, the data recently obtained are of great importance, particularly from studies of glacier crystal structure made in deep core drilling.

Possible reasons for the polarization changes of the signal have been analysed. Results of the analyses of the polarization diagrams obtained both at individual points and along extended traverses are discussed. It has been found that the signal reflected from a considerable ice thickness is polarized in such a way that the parallel orientation of the receiving and transmitting dipoles can be disregarded. *En route* recordings of the signal fluctuations obtained by parallel and orthogonally polarized dipoles are shown. The results of polarization studies are important for practical purposes. For example, bedrock relief sounding carried out with crossed dipoles makes it possible to get rid of interference signals occurring due to scattering from inhomogeneous structures of the upper part of the glacier.

PROGRESS IN RADIO-ECHO SOUNDING THEORY

By V. N. RUDAKOV and V. S. LUCHININOV

(Leningradskiy Ordena Lenina Elektrotekhnicheskii Institut im. V. I. Ul'yanova (Lenina), Leningrad, U.S.S.R.)

ABSTRACT. The inverse problem of radio-echo sounding consists in the reconstruction of subglacial relief from the known radio-echo profile, and the path, and speed of the aircraft. The present work shows that in the geometrical optical approach the solution of the inverse problem for a homogeneous, two-dimensional object (valley glacier) exists, and there is a unique solution. An algorithm for interpretation of the experimental data is suggested. It may be considered as the generalization of Harrison's transformations for any surfaces, paths, and speed.

The direct problem of radio-echo sounding consists in the reconstruction of radio-echo profile from the known surface and subsurface relief, path, and aircraft speed. The analysis of traces in the standard radio-echo sounding mode of operation reveals the possibility of introducing a three-index trace classification $\{K, \text{sign } S'(o), K_+\}$ where K is the number of real roots characteristic of the equations, K_+ the number of positive roots, and $S'(o)$ the position derivative, the argument being equal to zero. The form $\{o, -o\}$ is optimal for the precision of the calculation of the reflected surface coordinates, as well as for the simplicity of the interpreted picture. By a special choice of the altitude of flight, any form of any surface can be brought to $\{o, -o\}$. The decrease in beam width is equivalent to the diminution of roots of the characteristic equations. For a pencil beam the trace degenerates into a point.

The attenuation of the reflected signal depends on the glacier geometry, the dielectric parameters of the medium, the altitude and the course of the aircraft, as well as statistical characteristics of the mutual orientation of the interfaces and aeriels. For the description of the energetics of radio-echo sounding, equivalent reflecting surfaces are suggested. These surfaces correspond to the Harrison's equivalent reflecting surface. Exact formulae for the power of coherent and incoherent components of the reflected signal are obtained. Components of the full attenuation such as absorption, depolarization, and spherical divergence, are investigated with respect to refraction and focusing effects.