

ELECTROMAGNETIC REFLECTION FROM MULTI-LAYERED MODELS

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ABSTRACT. The remote sensing of snowpack depth, density, and wetness with an airborne system would have important applications in water resource management and flood prediction. In this paper, the electromagnetic response of multi-layered models is analyzed. Normally-incident plane waves are assumed at frequencies ranging from 10^6 to 10^{10} Hz, and reflection amplitudes are calculated for models having various layer combinations. Each layer can have arbitrary thickness, and its own dielectric constant and conductivity, each of which can vary with frequency. Thus "lossy" media as well as "perfect" dielectrics can be employed in the models. An outline of the theory for the calculations is presented for an n -layered model. Because of the complexity of the equations, interpretation is accomplished by illustrative models, selected from seven snow types and seven earth types. The objective of this type of calculation is to establish the dependence of the reflection coefficient on the impedance transitions between two half-spaces. This paper is a theoretical study only, and does not include consideration of the size, weight, estimated cost, and other physical attributes of a flight system. These, and other matters of a practical nature, are being treated in other papers.

A revised version of this paper is being published in full in another issue of the *Journal of Glaciology*.

DISCUSSION

M. V. BERRY: Your theoretical treatment neglects wavefront curvature, interface undulations, and bulk inhomogeneities. To what extent do these effects threaten the applicability of your proposed method?

W. I. LINLOR: For typical snow packs the radiation wavelength is greater than the snowpack depth so the roughness should be no great problem. A treatment including curved waves would be rather complicated, but should be done for practical situations. In principle, the treatment is similar to the plane-wave case.

AN EXPERIMENT IN ICE PROFILING IN NARES STRAIT AND THE ARCTIC OCEAN

By R. T. LOWRY

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ABSTRACT. This paper discusses the work being done at the Defence Research Establishment Ottawa (DREO) on profiling of Arctic sea ice using airborne laser profilometers. Data from a flight in March 1973 have been partially analyzed and some results are presented. These include representative ridge counts and power spectra for chosen areas in Nares Strait and the Arctic Ocean. Some work has been done to try to improve the operation of the laser profilometer using real-time data processing. The basic ideas behind this scheme are outlined.

DISCUSSION

D. F. PAGE: Is the data obtained from such profile experiments a function of direction of flight over the ice, and if so, how does this affect your interpretation of the data?

R. T. LOWRY: We found nothing to indicate preferred ridge orientation. Perhaps Bill Hibler may have more to say about that.

W. D. HIBLER III: There have been some studies on ridge orientation, and it has generally been found that on a small scale no preferred orientation is typically shown, and directional effects are not extremely large. On a large scale the nature of sequential deformation of pack ice suggests that anisotropy should be less of a problem. Perhaps more important, mean ridge height is not dependent on the ridging being isotropic and correlation with frequency seems to be fairly consistent.

W. F. WEEKS: When you look at sea ice you commonly see a set of highly oriented leads, and it is easy to assume that the ridges are oriented too. However, this is not necessarily so, as the leads represent the deformation of one instant in time, whereas the ridges have been formed over a period as long as the life of the pack ice, in the course of which the floes have rotated and changed their relative orientation.

G. DE Q. ROBIN: I understand that SLAR and IR imagery were obtained at the same time as the laser profile. This should give information on any non-isotropic distribution of leads and ridges.

LOWRY: None of our sensors showed any preferred orientation of ridges.

S. G. TOOMA: Just a thought on the "glitches" you mentioned in the end of scale effects. These might be caused by the laser beam striking the side of a ridge, resulting in a specular reflection away from the laser, causing a momentary loss of signal. The system recycles until the signal is again received, resulting in ice level changes of any height up to the basic full scale you are using.

LOWRY: That may well be part of the problem. However, we discussed the problem with the manufacturer of the instrument and were told the errors are inherent in using the "range expander" circuit over rough ice. The device is not yet perfected.

SEA ICE FROM BELOW: SONAR TECHNIQUES

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ABSTRACT. Under-ice sonar surveys were carried out in pack-ice fields near Fletcher's Ice Island and at two sites north of Pt. Barrow, Alaska, U.S.A. A narrow-beam scanning sonar was used to measure the location and relative back-scattering of features on the under surface of Arctic sea ice. The 48 kHz sonar had a 1.5° by 51° beam width. Graphic records displaying the range and relative scattering levels were assembled into sonar maps which display location and shape of under-ice features. Two distinct types of back-scattering were found: (1) very high-level back-scattering from well defined under-ice ridges and (2) very