

Use of Georadar in Support of Satellite Remote Sensing Investigations of Lake Ice Cover

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EXTENDED ABSTRACT

Lakes are a conspicuous feature of the Canadian landscape and, in subarctic regions, they are covered by ice and snow 8 to 10 months of the year. Lake ice is important not only as an indicator of the meteorological or climate conditions of a region (through variables such as ice thickness, as well as freeze-up and break-up dates), but also of interest in the context of the biological productivity of lakes and water resources management of northern settlements.

The objective of this research, which is being conducted as part of the Canadian EOS-CRYSYS program, is to study the spatial and temporal evolution of ice cover from shallow subarctic tundra and forest lakes. Two approaches are currently being used to study the evolution of ice-cover from these lakes: space-borne SAR imagery from RADARSAT and ERS-1/2, and GPR (Ground-Penetrating Radar). This study focused on the use of a GPR.

Field observations on the structural and stratigraphic characteristics of ice cover from four lakes located near Churchill, northern Manitoba, were acquired during three field campaigns (February, March, and May 1998) along with ground probing radar profile measurements made on the same lakes in March and May 1998. The georadar acquisitions were obtained in reflection and CMP modes at 225, 450 and 900 MHz frequencies.

The major findings of this study are as follows:

1. The CMP profiles are more informative than the reflection profiles for lake ice studies. CMP profiles not only allow to derive velocities and dielectric constants, but also the exact depth of each reflector. This facilitates any comparison with the ice cores.
2. The velocities and dielectric constants which, in this study, were superior to or inferior to typical values published in the literature, could be explained on the one hand by the presence of snow cover on the ice and on the other hand by the presence of air bubble inclusions within the ice volume. The GPR could therefore be used to estimate bubble density within an ice layer.
3. A greater number of reflectors were observed within the ice volume at higher frequencies. Following the analysis of several CMP profiles, it appears that the maximum vertical resolution of the signal is 8 cm at 450 MHz and 2 cm at 900 MHz.
4. The maximum penetration depth of the signal observed on the profiles was 1.72 m at 900 MHz, 3.90 m at 450 MHz, and 4.60 m at 225 MHz. The penetration depth of the signal is therefore greater at lower frequencies.
5. The GPR profiling method developed in this study represents a promising approach for future spaceborne SAR investigations of lake ice cover, since GPR profiles allow one to extend the single point measurements (ice cores) to that of a satellite pixel.

Key words: Lake ice, georadar, remote sensing, subarctic Canada.

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