Inversion Algorithm for Thickness of Saline Ice under Diurnal Thermal Cycling Conditions

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Abstract

The growth of sea ice is strongly affected by the dynamic environmental conditions and the resultant physical and morphological characteristics of ice will complicate the interactions of sea ice with electromagnetic radiations. As a result, the direct use of a simple empirical model for sea ice thickness retrieval becomes limited. An experiment was carried out, at the Geophysical Research Facility in the Cold Regions Research and Engineering Laboratory in 1994, to investigate the polarimetric backscatter of saline ice grown under diurnal temperature variations, and a strong correlation has been observed between the ice surface temperature and radar responses during ice growth.

In this work we develop a thickness retrieval algorithm based on a dynamic electromagnetic scattering model of saline ice and the time-series active remote sensing measurements. This direct scattering model consists of a saline ice physical model describing the dynamic variations of ice characteristics under diurnal thermal conditions coupled with an electromagnetic scattering model accounting for wave propagation and scattering in a multilayer random medium with rough interfaces. Interpretations of CRREL-EX 94 experimental results are demonstrated. The inversion algorithm using time-series data is formulated based on this direct scattering model and a parametric estimation scheme which minimizes the difference between backscatter data and model responses subject to physical constraints imposed by sea ice growth physics. This inversion algorithm is then applied to reconstruct the growth of a sheet of thin saline ice by using the C-band polarimetric radar sequential measurements from the CRREL-EX 94 experiment. The inversion results are compared with the ground truth measurements.