Assessment of Sea Ice Thickness Inversion from Backscatter Data

S. V. Nghiem[1], R. Kwok , S. . Yueh[1], A. J. Gow[2], and D. K. Perovich[2]

[1]Center for Space Microelectronics Tecl nology
Jet Propulsion Laboratory, California Institute of Tech nology
Pasadena, California 91109

[2] .S. Army Cold Regions Research and Engineeri ng Laboratory
Hanover, New Hampshire

Abstract

The thickness inversion of young sea ice from backscatter data depends on the sensitivity of the radar return to ice thickness. Backscatter can come from surface or volume scattering mechanisms. For surface scattering, it is not clear how the backscatter is related to the thickness of the ice sheet under the scattering surface. For volume scattering, the brine fractional volume reduction with thickness can lead to less scatterers; however, the attenuation is also decreased at the same time. To assess the inversion of sea ice thickness, an experiment was carried out to measure polarimetric backscatter signatures at C band together with physical characteristics of thin saline ice. In this respect, the purpose of the experiment is to determine the fundamental feasibility of the thickness inversion under the simple controlled laboratory conditions. If it is feasible in this case, then more complicated conditions can be added in future experiments to investigate their effects on the inversion problem. To approach the problem by starting with all complicated environmental and meteorological field conditions will lead to difficulties in understanding the observations let alone the development of computational algorithms to retrieve sea ice parameters from remote sensing data. Thus, controlled laboratory conditions are utilized to avoid complicated variations in interrelated characteristics of saline ice and the environment. The ice sheet was grown at a constant rate under quiescent conditions in a refrigerated facility at the U. S. Army Cold Regions Research and Engineering Laboratory. Growth conditions, thickness and growth rate, temperatures and salinities, and internal and interfacial structures of the ice sheet were monitored. Measurements indicate that the laboratory saline ice has characteristics similar to thin sea ice in the Arctic. A strong increase of 6-10 dB is observed in the backscatter, at incident angles from 20° to 35°, as the ice grows from 3 cm to 11.2 cm in thickness. Ice characteristics and processes suggest that the large enhancement in backscatter relates to the interconnection and increase in the size of brine inclusions during the desalination process. Furthermore, backscattering coefficients of the saline ice sheet are shown to be similar to airborne radar measurements of thin sea ice growing in newly opened leads in the Beaufort Sea. For the inversion, the large increase in backscatter indicates that the ice thickness is retrievable for thin ice grown under the conditions in this experiment.