Experimental verification of the medium thickness estimation technique based on frequency- and angular-correlation functions

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The estimation of sea-ice thickness using the frequency- and angular correlation functions (FCF and ACF) at VHF frequency SAR has been proposed recently. The model is based on the layered structure which consists of snow, sea-ice, and sea-water. The analytical model for first-year ice is based on the small perturbation method and, for multiyear ice, the Kirchhoff approximation. The returned signal is dominated by the top and bottom rough surface boundaries of sea-ice and it contains the phase interference effects. The sea-ice thickness is derived from the interferometric phase of the ACF/FCF function of two VHF-band returns of two radar waves that have different frequencies, incident angles, and observation angles. In order to increase the signal coherence, the angles and frequencies must be adjusted so that the correlation function stays close to the memory line of rough surfaces.

In this paper, we will discuss the experimental verification of the proposed ACF/FCF method. Because it is difficult to conduct the lab experiment using VHF radar, the scaled model is developed at K- or Ka-band. The system consists of a vector network analyzer and two antennas operating at K- or Ka-band. The sea-ice is simulated by a low density plastic slab with rough surfaces fabricated on it. The ensemble and frequency averaging techniques are used in order to increase sample numbers and reduce noise. The inversion process to estimate the ice thickness is based on several methods including gradient-descent (GD), least-square (LSQ) method, and Neural network. Compared with the GD and LSQ method, Neural network does not require knowledge of the derivative of the ACF/FCF function.