Multiple scattering contributions to HF radar echoes from ice-covered seas

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The dramatic retreat of Arctic sea ice over the past forty years, with its attendant geopolitical and environmental implications, has greatly increased the need for reliable, wide-area, real-time, remote sensing of ice characteristics in the Marginal Ice Zone. A recent study (S. J. Anderson, Proc. IEEE Int. Radar Conf., Seattle, May 2017) explored the possibility of employing HF radars to monitor ice characteristics via interpretation of the Doppler signature of motions induced by waves penetrating the ice field from the surrounding ocean.

In order to compute the response of the inner regions of the ice field to the stimulus of the incident waves, two transport-type problems must be solved. The first is hydrodynamic in nature, namely, the evolution of the spectral characteristics of the wave forcing as the wave undergoes refraction, absorption, dispersion and filtering in the course of its progression through the MIZ. We have adapted several existing models of the incremental transformations and implemented integration schemes to determine the hydrodynamics deep within the ice field. The second problem is electromagnetic in nature, namely, the evolution of the amplitude, phase, polarization and directionality of the interrogating radio wave as it propagates across the rough, time-varying MIZ medium to a given spatial cell of interest. Here we consider the case of an HF surface wave radar. In previous work, only the amplitude variation was considered, with other signal characteristics assumed to be those of the pristine signal as it left the radar transmitting antenna. A similar idealized propagation model was employed to describe the passage of the echo from a given radar cell back to the radar receiver.

Based on the encouraging conclusions of the previous study, it is now appropriate to add greater realism to the overall model (see Fig.1) by incorporating the effects arising from (i) the complexities of electromagnetic propagation in a three layered medium, and (ii) multiple scattering during propagation. In the present paper we address the latter problem, and evaluate the contributions of multiple scattering to the Doppler signatures of the various ice forms.

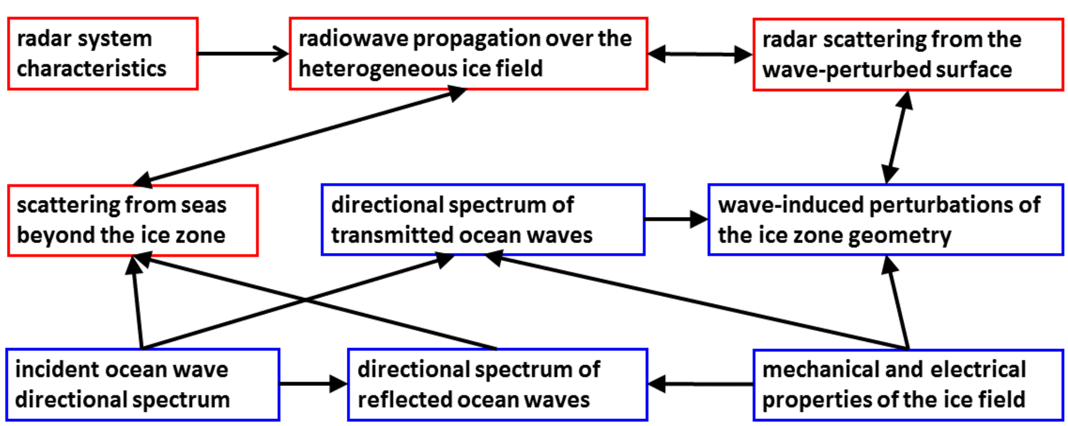

Figure 1. Components of the MIZ radar signature model