Modelling Microwave Scattering From Rough Sea Ice Surfaces

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Abstract

Sea ice is an important indicator for global climatic changes. Synthetic Aperture Radar (SAR) has been extensively used to monitor sea ice due to rough weather conditions in remote Arctic area. To better understand how SAR signal interacts with the sea ice, Electromagnetic Modeling (EM) studies can be undertaken to simulate the scattered signal from hypothetical sea ice. In this work, we model the microwave scattering from the sea ice surface using COMSOL Multiphysics®.

The RF module is used to study the problem. Figure 1 shows the geometry of the problem. A rectangle Perfectly matched layer (PML) is set to surround air and sea ice domain. So the computational domain is truncated by the PML layer. The rough interface is generated in MATLAB® by Discrete Fourier transform and the model is manipulated through LiveLink™ for MATLAB®.

The incident wave needs to be defined for the FEM formulations. The implementation of a plane wave can cause errors due to reflections from the edges of a finite surface. The tapered incident wave or periodic boundary conditions can be used to solve the problem. When using the tapered incident wave, we implement a Total/Scattered field formulation strategy. For the air domain the scattered field formulation is used and the total field formulation is applied on the sea ice domain. The two different physics mechanisms are coupled through the boundary conditions on the interface between air and sea ice. Then the far-field calculation is implemented along with the scattered field formulation in the air domain. Another model based on the Floquet periodic boundary condition is also built. A port is set to emit a plane incident wave and several diffraction order ports are used to receive the reflected waves. The number of ports are generated automatically in COMSOL Multiphysics®. Then the bistatic and monostatic radar cross section can be calculated.

The results from the methods are compared with commonly used methods SPM and MOM. Good agreements are achieved. Most methods can only model the scattering from homogeneous sea ice. The model in this work can be easily extended for inhomogeneous multi-layer sea ice. Through modeling we can observe how scattered radar signal changes with different permittivity profiles.

Figures used in the abstract

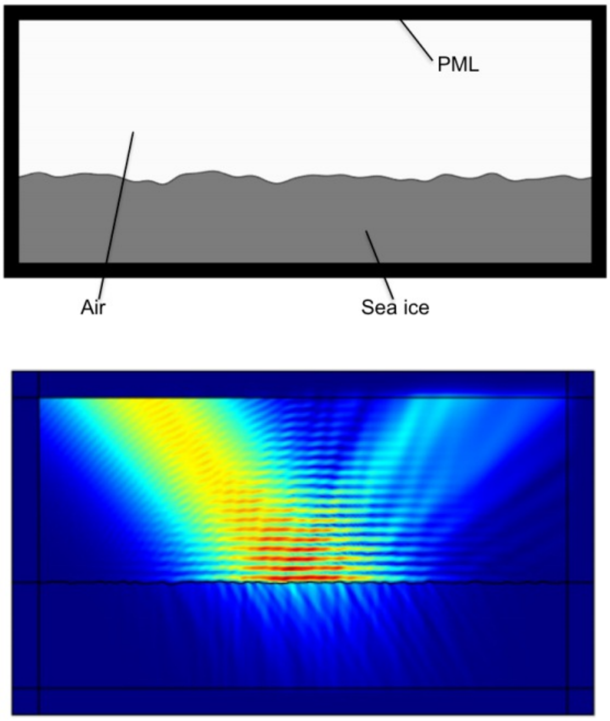

Figure 1: Top: Model geometry, bottom: microwave scattering from rough sea ice surface