Modelling and Analysis of Cross-Polarized Radar Backscatter at C, X, and Ku Bands for SWE Retrieval Algorithm

FIROZ BORAH[1], ZHENMING HUANG[1], LEUNG TSANG[1], AND EDWARD KIM[2]

ABSTRACT

There have been many studies of radar backscatter response to snow which include satellite (Sentinel-1), airborne (NASA SnowEx) and tower-based radar measurement (NoSREx) at C, X, and Ku bands and even planned future satellite missions. These studies have been vital in developing and advancing the X and Ku dual frequency retrieval algorithm for SWE (snow water equivalent). Although the primary focus of the algorithm is the co-polarized radar backscatter, the cross-polarized signal can give important details about the snowpack as well. As such, studying and modelling cross-pol radar backscatter from snow correctly and accurately is important.

The cross-pol is predicted by modelling snow as a bi-continuous media of air and ice, controlled by grain size parameter k_c and aggregation parameter b and then solved using the DMRT (dense media radiative transfer). Parameter b is kept small ($b = 0.4$) to have clusters of ice particles which increases the cross-pol. The DMRT equations are solved iteratively, and it can be shown that cross-pol majorly contributes to the higher order terms. Including the backscattering enhancement results in 2.5-3 dB enhancement for co-pol and cross-pol backscatter, which increases the cross-pol to co-pol ratio as predicted by Sentinel-1. The cross-pol radar data is also used to reduce the need for prior information when doing the SWE retrieval using the X and Ku dual frequency algorithm. The cross-pol radar measurements are used to do the classification of the co-pol radar data and this classification is used to drive the algorithm to find the correct solution for SWE. This method is validated using both airborne and tower radar data.

[1] Radiation Laboratory, Department of Electrical and Computer Engineering, University of Michigan, Ann Arbor, MI, USA

[2] NASA Goddard Space Flight Center, Greenbelt, MD, USA

Corresponding author: firozb@umich.edu