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Investigating Microwave Emission Variability in Snow using Artificial Neural Network Retrievals and the Improved Born Approximation

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Snow cover plays a crucial role in Earth's energy budget as both a reflective and insulative material. Accurately representing snow properties in climate models and weather forecasts is challenging due to their high spatial and temporal variability, which is particularly important in the polar regions. This variability affects microwave radiative transfer, leading to significant uncertainties in satellite retrievals, reanalysis products, and climate models. However, passive microwave satellite measurements provide valuable insight into snowpack properties by capturing radiation at multiple frequencies, each with different penetration depths.

This study compares frequency-dependent effective surface temperatures retrieved from Advanced Technology Microwave Sounder (ATMS) brightness temperatures using an Artificial Neural Network (ANN) to model simulations based on the Improved Born Approximation (IBA). The IBA offers a physically consistent framework for modelling microwave interactions in snow by accounting for both absorption and multiple scattering within a granular medium. By comparing ANN retrievals to IBA-modelled brightness temperatures, this work explores what can be learned about snow microstructure and its impact on microwave radiative transfer. Ground-based observations from the Cold Regions Research and Engineering Laboratory (CRREL) ice mass balance buoys and the Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) expedition are used for validation.

This analysis provides insight into how ANN-based retrievals can capture the complex variability of snow properties and assesses their potential for improving microwave-based observations of polar regions, which could, in turn, improve climate modelling of these regions.

Keyword-1

Satellite Remote Sensing

Keyword-2

Radiative Transfer

Keyword-3

Polar Climate

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