MODELING MICROWAVE EMISSION AT HIGH FREQUENCY FROM STRATIFIED SNOW USING DENSE MEDIA RADIATIVE TRANSFER THEORY BASED ON THE QUASICRYSTALLINE APPROXIMATION (QCA/DMRT)

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1. ABSTRACT

The multi-layer dense media radiative transfer (DMRT) theory based on the quasicrystalline approximation (QCA) has been applied for studying both passive and active microwave remote sensing signatures [1], [2]. It is shown that the layered structure is essential to analyze the microwave emission from snow because high frequency is sensitive to the scattering from the medium top and low frequency is sensitive to the entire snow pack. Compared to those from single layer QCA/DMRT model, multilayer QCA/DMRT model predicts higher polarization difference and weaker frequency dependence of brightness temperatures than a homogeneous single layer snow model. Also, brightness temperatures at 18.7GHz and 36.5GHz from the multilayer model are in better agreement with ground observations. For broader applications of QCA/DMRT, we need to further study simulations at higher frequency and compare with the Ground Based Microwave Radiometer (GBMR) observations of Tb at 89 GHz. Such an extension will benefit the remote sensing of surface properties from Advanced Microwave Sounding Unit-B (AMSU-B), Microwave Humidity Sounder (MHS), Special Sensor Microwave Imager and Sounder (SSMIS), and Global Precipitation Measurement (GPM) Microwave Imager (GPMI). The DMRT theory takes into account the collective scattering effects of the particles by including the wave interactions among the particles [3]. The QCA/ DMRT model gives different results when compared to classical independently scattering theory: 1) The extinction saturates at high fractional volume, 2) The

scattering coefficient has a frequency dependence that is weaker than the fourth power in spite of the smallness in size of the particles, 3) The mean cosine of the phase matrix is not equal to zero, and 4) The phase matrix shows more forward scattering and has a larger mean cosine than the classical Mie scattering theory of the same grain size. In this paper, we simulate high frequency Tb at 89GHz using snow parameters measurements at Local Scale Observation Site (LSOS) of the Cold Land Processes Field Experiment (CLPX), Colorado, USA, in Feb. 2003 as input to the multilayer QCA/DMRT model and compare with the GBMR observations. With one set of physical snow parameters, the QCA/DMRT model can predict all 6 channels of Tb (18.7GHz, 36.5GHz, 89GHz, vertical and horizontal polarization) observations simultaneously.

The snow parameters measurements provide nine sets of grain size, which includes three groups for each layer: small, medium and large and three values for each group: maximum, minimum and average. Tb from multilayer snow is also simulated using these nine sets of grain size measurements respectively. Comparisons with GBMR measurements show that in order to get good Tb simulations, the grain sizes use in the model should be smaller than average measurements.

The study in this paper also will explore the feasibility of simulating snow emissivity at frequencies above 89 GHz since satellite measurements at 150 and 183 GHz also play important role in microwave remote sensing and satellite data assimilation systems.

2. REFERENCES

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