QUANTIFYING INTER-COMPARISON OF THE MICROWAVE EMISSION MODEL OF LAYERED SNOWPACKS (MEMLS) AND THE MULTILAYER DENSE MEDIA RADIATIVE TRANSFER THEORY (DMRT) IN MODELING SNOW MICROWAVE RADIANCE

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1. INTRODUCTION

MEMLS is a multilayer model based on radiative transfer theory, using six-flux theory to describe multiple volume scattering and absorption, including radiation trapping due to internal reflection and a combination of coherent and incoherent superposition of reflections between layer interfaces[1]. The extension model of MEMLS to coarse-grained snow uses the improved Born approximation to determine the volume scattering coefficients where the snow structure is described by the spatial correlation function [2] . The model description for computing scattering and absorption coefficients has been tested on many snow samples and validated against actual snowpack. The relationship between snow grain size and the MEMLS snow correlation length has been explored [3] . Wiesmann (2000) used two well-known snow models, Crocus and SNTHERM, to obtain snow profiles from meteorological data and then as input to the Microwave Emission Model of Layered Snowpacks (MEMLS) for the simulation of microwave radiation [4] . The results showed the potential of combined snow-physical and microwave-emission models for understanding snow signatures and for developing snow algorithms for microwave remote sensing. Dueand (2006) use the MEMLS to make a feasibility of multifrequency radiometric data assimilation to estimate snow water equivalent [5] . The results indicate that the ensemble approach is ideal for investigating the complex theoretical relationships between the snowpack properties and the observations, and exploring the implications of these relationships for inversion of remote sensing measurements for estimating snowpack properties. Recently, Dutand (2008) characterize the uncertainty of MEMLS in modeling snow microwave radiance using the CLPX data [6]. In addition to the approach taken by MEMLS, there are other schools of thought in the field of modeling the microwave emission from snow. Dense medium Radiative Transfer Theory (DMRT) is the most rigorous approach to modeling microwave emission from snowpacks [7]. It takes into account the coherence of the scattering among the snow grains. The pair distribution functions of the Percus-Yevick approximations for sticky particles are used to simulate the adhesion of ice grains and the formation of clustering. Due to using the higher order multipoles to account for the clustering effects, the QCA/DMRT model gives snow different results when compared to classical independent scattering theory [8] . Wilson (1999) and Chen (2001) developed a three-component retrieval algorithm by combined using of single-layer DMRT and a physically based snow hydrology model that incorporated meteorological and topographical data, and a neural network (NN)[9-10] . Tedesco (2006) made a comparison of local scale measured and modeled brightness temperatures and snow parameters from CLPX 2003 using a single-layer QCA-CP/DMRT model [11] . Later, they observed and modeled the brightness temperatures of snow melting/refreezing cycles using a two-layer QCA-CP/DMRT[12] . Liang (2008) improve the improved Tedesco's method to deal with arbitrary number of layer based on QCA/DMRT[13] , which is applicable for moderate grain sizes without low frequency formulae limit.

As the addressed above, the two model results were found to be in good agreement with the experiments data, however, comparing the results of different snow models, when driven with the same set of input parameters, can benefit remote sensing of snow. Tedesco and Kim (2006) evaluated several one-layer electromagnetic models for passive remote sensing of snow[14] , however, sufficiently comparisons of multilayer model to definitively determine which the better approach is meaningful, which should include the effects of stratification due to ice-layer and depth hoar and the sensitivity of model to the input parameters.

2. DATA AND METHOD

In this study, we use snowpit and microwave radiance measurements collected during the NASA Cold Land Processes Experiment (CLPX)[15] . The study area was the local-scale observation site (LSOS), which was the most intensivly measured sit in the CLPX. The data collected at the LSOS allows for a complete and detailed characterization of the local snow conditions, soil properties, vegetation, and energy balance characteristics. In this paper, the LSOS snowpit and radiance data are used collected form the third intensive observing period (IOP) in February 2003. During this time, the snow conditions were generally frozen and dry.

At First, we compare the accuracy of MEMLS with multilayer QCA/DMRT using the same multilayer snowpit inputs. Because snowpit measurements and GBMR-7 radiance data are not available at precisely the same time, the measured brightness temperature within the minimum time interval from the snowpit were selected to compare with the brightness temperatures model simulated. Secondly, instead of comparing the modeled results with the GBMR-7 measurements, we give some typical errors in the inputs and simulate the brightness with different model to evaluate the sensitivity of model in order to evaluate the stability of model.

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