SIMULATION OF SPACEBORNE MICROWAVE RADIOMETER MEASUREMENTS OF SNOW COVER USING IN-SITU DATA AND EMISSION MODELS

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1. INTRODUCTION

Seasonal snow cover plays an important role in the hydrological and climatological processes of the boreal zone. The influence is due to the unique properties of snow: high albedo and thermal emissivity, low thermal conductivity, and latent heat sink in melting snow [1]. The water runoff from melting snow is a key parameter in the global water cycle. To predict the beginning of snowmelt and the amount of runoff water from melting snow, continuous information on several snow parameters (water equivalent, covered area, depth) are needed, especially during springtime. Besides operational snow courses and weather stations, spaceborne microwave radiometer observations can be used to provide daily large scale information on snow cover. Several operational systems for satellite-based mapping of snow are ongoing (e.g. [2]).

In order to extract snow data from spaceborne brightness temperature measurements, emission from soil, vegetation and atmosphere has to be taken into account. The properties of snow (e.g. grain size and shape, moisture content) also have an effect on its microwave emission. There are several algorithms for modeling of microwave emission from soil, vegetation canopy and snow cover. Empirical algorithms for estimating snow parameters are retrieved by analyzing measurement data. However, the use of empirical regression coefficients reduces the regional and temporal applicability of such algorithms. On the other hand, purely theoretical emission models tend to be too complex and thus not feasible for inversion of satellite data. Therefore the empirical and semi-empirical models used here, namely HUT snow emission model [3], rough bare soil reflectivity model [4] and boreal forest transmissivity model [5], are selected for their simplicity and generality.

2. METHODOLOGY

The validity of the chosen models is studied here by combining them to simulate time series of microwave brightness temperature of snow-covered ground from an extensive in-situ data set collected during winter 2006–2007 in Sodankylä, Finland [6]. The simulated daily time series are compared to measurements by AMSR-E instrument on board EOS Aura satellite [7].

The purpose of this paper is to compare three different formulas for snow extinction coefficient: the original extinction coefficient used in HUT snow model by Hallikainen et al. [8], the newer formulation suggested by Roy et al. [9] and the one used in Middle East Technical University (METU) [10]. Hallikainen’s and Roy’s models were developed for taiga snow class [11] and METU model is a new empirical model for maritime snow. Daily brightness temperature time series for all the AMSR-E measurement frequencies were calculated for the whole winter with each of these extinction coefficient formulas.

3. RESULTS

Simulations of brightness temperature with all the three different extinction coefficient models and with different snow grain sizes are shown in Figure 1. The Figure shows that extinction coefficient models of [8] and [10] behave quite similarly, but that of [9] differs largely from the two others.

The comparison of time series shows, that [10] gives a bit smaller bias and larger rms error than [8]. Contrary to results of [9], Roy’s model does not show any drastic improvement on that of [8] in bias and rms error on 18.7 and 36.5 GHz, in fact on 36.5 GHz the bias doubles. The correlation between brightness temperature time series of AMSR-E measurements and simulations using [8] is about 0.8 on V polarization on all AMSR-E measurement frequencies, while correlations of time series with [10] range from 0.7 to 0.8 and with [9] range from 0.6 to 0.9. On H polarization all the models give poorer correlations ranging from about 0.3 on 6.9 GHz to about 0.8 on 89 GHz.
Fig. 1. The effect of snow grain size on simulated brightness temperature using extinction coefficient by a) [8], b) [9] and c) [10].

4. CONCLUSIONS

There are no big differences between the three extinction coefficient formulas. The used *in-situ* data set includes a wide range of snow conditions, which explains the overall similarity of the results from the different models: none of them is applicable to all situations. Especially the data set includes both dry and wet snow, while the extinction coefficient models have been developed only for dry snow.

5. REFERENCES


