Development of snow algorithm based on the microwave radiative transfer model for multiple layers and various land surface parameters

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Many snow retrieval algorithms based on the microwave remote sensing uses the microwave radiative transfer model (RTM) for a single snow layer structure and a lot of assumption for land surface parameters. We could not achieve the high estimation accuracy because our algorithm also has used same structure. Therefore, our RTM was modified as follows: Until now, the combined model of the Dense Media Radiative Transfer model (Tsang, 1992) and the 4-Stream fast model (Liu, 1988) was used in our RTM. In this study, the Advanced Integral Equation Model (AIEM; Chen, 2001) was added to RTM in order to evaluate the land surface scattering, and the multiple layer for snow and soil was applied in order to evaluate various parameter. For the vegetation, a vegetation water content is calculated by the Paloscia and Pampaloni (1988)’s empirical formula, and a vegetation optical thickness is calculated by Jacson and Schmugge (1991)’s empirical formula. Thereafter, it is evaluated by the Omega - Tau model (Mo et al., 1982). Furthermore, ice’s component was added into the Dobson et al. (1985)’s empirical formula in order to evaluate the soil freezing. Afterward, the sensitivity of RTM was checked in order to reduce of assumption parameters. In consequence, the porosity, ice content, snow temperature gradient for soil and the LAI and vegetation fraction for vegetation were applied as the land surface parameters. Subsequently, the lookup tables (LUT) for each land surface parameter were calculated by the modified RTM, and the snow retrieval algorithm, which estimates snow depth using the brightness temperature for 18.7/36.5GHz, was developed. Snow particle size was calculated by the snow grain growth model (Sturm and Benson, 1977), and snow temperature is calculated by the Richard (2003)’s empirical formula using the AMSR2 brightness temperature for 18.7(v), 23.8(v), 36.5(h) and 89.0(v) GHz. Furthermore, the Harmonized World Soil Database, the NSIDC Permafrost global map, the MODIS LAI map, the ESA Glob Cover Dataset were applied as the global ancillary data. Algorithm performance was validated from October 2012 to February 2013 at the Siberia 11 ground-based stations over the Siberia region (N55-65°, E125-135°), and the estimated snow depth was in good agreement with the in situ data. In the result, the developed algorithm was achieved MAE (Mean Absolute Error):9cm, Bias:1.5cm and RMSE:14cm.

Keywords: Snow, Microwave remote sensing, Algorithm

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