AMSR Snow Algorithm Development and Validation in the Eurasian continent

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The wavelength in the microwave region has sensitivity to the scattering effect of snow grains and leaves. Microwave remote sensing has potential of the measurement of snow water equivalent and water content of vegetation. The longer wavelength is one of the advantages of microwaves. It is long enough to reduce the scattering effect of cloud particles and to make microwave sensors useful all-weather ones. In this study, a new algorithm for snow depth and snow physical temperature by considering the effects of vegetation is developed based on the microwave radiative transfer theory. It is applied to the SSM/I and TMI data and validated by using the in-situ data in Russia and the Tibetan Plateau.

The microwave brightness temperature observed by satellites is expressed by the radiative transfer equation which consists of the soil surface radiation attenuated by snow and vegetation layers and their. A passive microwave sensor algorithm for snow is proposed based on the radiative transfer theory by introducing the effects of vegetation. The relationship between the land surface radiation and snow properties is obtained by the radiative transfer theory based on a scattering dielectric layer over a homogeneous half-space. The total land surface brightness temperature is the sum of the direct component and the diffuse component which corresponds to the reflected sky radiation and the thermal radio emission from snowpack and soil, and the radiation scattered from the direct and diffuse fields, respectively. By assuming snow grain size, snow density and radiation form soil-snow interface, brightness temperatures at two different frequencies are calculated by the radiative transfer equation by inputting snow depth and physical temperature. This forward model calculation was validated through the aircraft experiment in Japan. To evaluate the vegetation effects on microwave radiative transfer, three relationships among optical thickness in microwave region, water content of vegetation, LAI and NDVI. In microwave region, vegetation layer is characterized only by optical thickness, which is expressed by water content of vegetation. Water content of vegetation is related with LAI by using an empirical equation. According to the visible and infrared remote sensing, several relationships between LAI and NDVI were proposed. Based on those three relationships, the effects of vegetation on the microwave radiative transfer can be estimated by NDVI derived from visible and infrared radiometers.

By assuming constant values of snow grain size, snow density and soil surface emissivity, brightness temperatures at two different frequencies are calculated for each snow depth, snow physical temperature and NDVI. By applying a numerical inversion technique to the result of the forward model calculation, we can obtain a look-up table, which calculates snow depth and snow physical temperature by inputting observed brightness temperature at two different frequencies. In this paper, the proposed algorithm is applied to the data at 19GHz and 37GHz of DMSP SSM/I and TRMM TMI. NDVI is derived from NOAA AVHRR data.

A four years (1992-1995) data set based on in-situ measurements and SSM/I data was complied by Earth Observation Research Center (EORC) of National Space Development Agency (NASDA) of Japan. Snow parameters and climatology data from one hundred observational stations spread over the Northern Hemisphere were involved in the data set. Five closest SSM/I footprints were extracted from the swath data to form the coincide data set. A statistical analysis of the proposed algorithm was performed for the period of January 20 to 25, 1993. The algorithm retrieved snow depth at 69 stations from 100 and the mean absolute difference between the observations and estimations is 24.5cm. The algorithm was not able to infer accuracy the snow information from deep snowpacks. This is probably due to the limited penetration of 37GHz radiation.

The Tibetan Plateau has been suggested to play an important role in the variation of the Asian summer monsoon through its atmospheric heating processes. The Intensive Observing Period (IOP) was implemented in 1998 for the purposes of establishing the satellite-based observing systems and clarifying the interactions between the land surface and atmosphere over the Tibetan Plateau. The closest footprints of TMI to the Automatic Weather Stations (AWSs) were used to make a match-up data set. The estimated snow physical temperature is in good agreement with the observed surface temperature by using the infrared thermometer as shown in Fig. 3, although the snow depth has not been validated because the lack of the ground-based snow depth data.