Snow Parameter Retrieval from Water Cycle Observation Mission

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Snow cover is one of the most important parameters in the cryosphere. It is closely related to the earth's energy budget as the snow cover can reflect a large part of incident solar radiation because of its high albedo. Water Cycle Observation Mission (WCOM) is a mission that focuses on the research of water cycle key elements, including soil moisture, ocean surface salinity, snow water equivalent and frozen/thaw. WCOM is equipped with Dual Frequency Polarized Scatterometer (DFPSCAT), Interferometic Microwave Imager (IMI) and Polarimetric Microwave Imager (PMI). DFPSCAT is an X/Ku band rotating pencil beam scatterometer with 2-5 km resolution and 1000km swath for mapping of snow water equivalent (SWE) and freeze-thaw process. Based on the payloads of WCOM mission, especially with X/Ku scatterometer and L/Ku/Ka radiometer active/passive observations, there are obvious advantages in snow water equivalent retrieval. The atmospheric correction of active and passive data should be performed before the retrieval. The estimation of SWE mainly rely on the high resolution X and Ku band scatterometer, and combined active/passive retrieval can provide more reliable SWE product. The retrieval method of SWE and snow wetness from X/Ku scatterometer is described.

When snow becomes wet, snow backscattering signals decrease rapidly. This is because the permittivity of snow increase dramatically and this cause a significant increase in depth of penetration. Then the snow volume backscattering components would be too weak to be considered. This phenomenon can be used to discriminate dry snow and wet snow.

The method of retrieval algorithm for SWE estimation from X/Ku scatterometer is based on a physical model in which the snow scattering is simulated by the bi-continuous vector radiative transfer model and the soil surface backscattering before snowfall is regarded as the ground backscattering under snow cover. A new parameterization scheme is developed for snow volume scattering in which the snow volume scattering is represented as a quadratic polynomial of the fist-order solution of snow volume radiative transfer equation. We also found good relationships for the single scattering albedo and snow optical thickness at X and Ku bands. The SWE is finally estimated through an iteratively minimized a cost function with prior constraints. Validation against two-year measurements of the SnowScat instrument from the NoSREx campaign shown in Figure 1 shows that the estimated SWE with the algorithm has a root mean square error (RMSE) of 16.59 mm for winter in 2009–2010 and 19.70 mm for winter in 2010–2011, respectively.

We also made a preliminary study of snow wetness estimation based on the quasi-crystalline approximation - dense media radiative transfer model. Firstly, the snow volume backscattering is decomposed using the cross-polarization VH and the co-polarization VV backscattering signals, then surface backscattering at air-snow interface at X and Ku bands can be obtained. Because surface backscattering is the function of snow wetness and surface roughness, snow wetness can be expressed as the function of surface backscattering and surface roughness based on the simulated database. After using the surface backscattering at X and Ku bands, the effect of surface roughness can be eliminated. Finally, snow wetness can be estimated. The result is compared with the input values of snow wetness from the forward model shown in Figure 2.

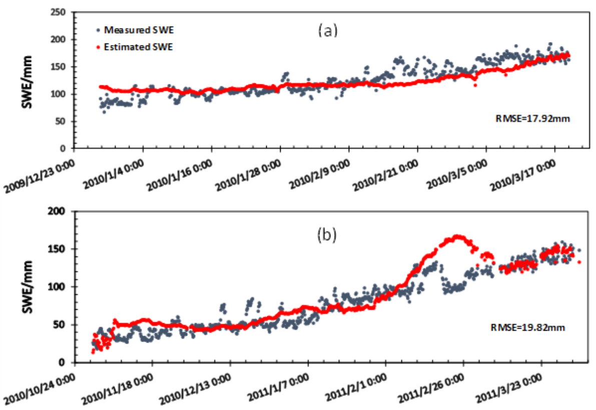

Figure 1. The time series of observed SWE (black) and estimated SWE (red).

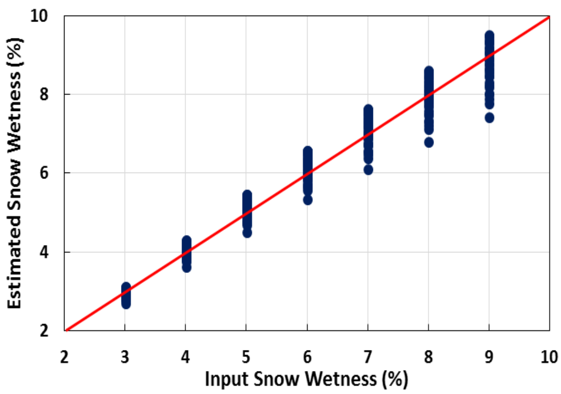

Figure 2. Comparing the estimated snow wetness (y-label) with model input snow wetness (x-label).