Estimate Bare Surface Soil Moisture from L-Band AIRSAR with an Improved IEM

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Soil moisture plays an important role in the interactions between the land surface and the atmosphere, as well as the partitioning of precipitation into runoff and ground water storage. In spite of its importance, soil moisture has not found a widespread application in the modeling of hydrological and biogeochemical processes and related ecosystem dynamics, in part because soil moisture is a difficult parameter to measure on a large area, cost-effective, and routine basis.

In attempt to use active microwave remote sensors in estimation of soil moisture, we are mainly facing two major problems: effects of surface roughness and vegetation cover. There are several algorithms developed for measurement of bare soil moisture quantitatively using dual or three polarization L-band SAR image data. A common idea beyond these algorithms is to separate the effects of the surface dielectric and roughness properties on the backscattering signals to present the model, which the inversion was based on, as a product of a dielectric function and a roughness function. They are first-order statistical inversion models. Depending on the data source, the selection of the surface roughness parameters and the backscattering measurements of the different polarizations or their linear combinations, the models have a great difference in terms of both the dielectric and roughness functions.

As predictions of the tradition backscattering models from Small Perturbation, Physical Optical to Geometric Optical models, the polarization magnitudes that relating radar measurements to surface soil moisture changes as the surface roughness condition changes. It indicates that the sensitivity of radar measurements to soil moisture depends on the surface roughness condition. On the other hand, our sensitivity analyses have indicated that the radar measurements are more sensitive to the surface roughness properties than that to the dielectric properties. It is expected that the surface roughness parameter can be estimated more accurately than that for soil moisture when we apply a single algorithm.

In this study, we will show the validation of the recently improved IEM model with Michigan's truck-mounted scatterometer experiment data. The result indicates that a significant achievement can be obtained, especially in predicating the relationship between HH and VV polarizations. Using this model, we simulated a database with the wide range of soil moisture, surface rms height, correlation length, and correlation functions. We then evaluated the characteristics of the effects of surface roughness parameters and soil moisture on backscattering coefficients and developed a semi-empirical model. A technique to estimate surface soil moisture is developed based on the repeat-pass concept. In addition, we also considered the different type error sources on the algorithm performance. The results have much better accuracy in estimation of soil moisture. We will show the testing of our newly developed algorithm with JPL/AIRSAR data.