Estimation of Soil Moisture over Bare and Vegetated Surfaces Using SAR Polarimetric Data

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Abstract

Surface soil moisture on a regional or global scale, in particular in low vegetated surfaces such as arid, semi-arid, and agricultural landscapes plays an important role in understanding the global hydrological cycle by impacting the partitioning of incoming radiative energy to sensible and latent heat fluxes. In the past few years, several algorithms have been developed to retrieve surface soil moisture from microwave active and passive sensors, Most of these algorithms are only fipplic.able to bare soil surfaces and in the presence of vegetation perform poorly. For example, the three soil moisture. algorithms developed by Oh et al (1992), Dubois et al (1 995), anti Shi et al (1 995) for polarimetric SAR applications are primarily used for bare surfaces. In the presence of vegetation, the scattering properties of the sur.face changes, suggesting a different sensitivity of the SAR backscattered signal to soil moisture. In this paper, we formulate the scattering properties of vegetation for surfaces covered by pasture. and agricultural crops. The model is based on the wave theory and treats the vegetation layer by two variables, extinction depth and scattering cross section. These two variables are related to the water content of the vegetation and structural parameters. The underlying rough surface backscattering mode] is a reduced version of the Integral Equation Method (IEM) that has two parameters, soil dielectric constant and rms height. To develop an algorithm for soil moisture, the vegetation structural parameters are determined through a set of model simulations and training over known vegetation types from SAR images. The resulting equations for SAR polarimetric back scatter has three unknown parameters, surface rms height, vegetation water content, and surface soil moisture. These three parameters are obtained by using, L-band HH, HV, and VV polarization data. The algorithm is applied to SIR-C image.s acquired during the April and October of 1994 over Wasita watershed in southwest Oklahoma. The accuracy of the results are determined by using the field data collected during the shuttle missions and compared with the accuracies obtained with existing soil moisture algorithms.

Key Words: soil moisture, SAR polarimetry, canopy water content.

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