L-band Effective Scattering Albedo Inversion from Vegetation over a Growth Cycle

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In radiometric remote sensing of soil moisture through vegetation canopies, a zero-order radiative transfer approach, called the *tau-omega* model, is largely utilized in the hydrology community. The model has several advantages such as simplicity (very few parameters), ease of inversion and implementation, and extensive validation over many types of vegetation. The model links terrain geophysical variables to the observed brightness temperature through microwave reflectivity and two vegetation parameters, the optical depth and the single-scattering albedo.

The vegetation parameter "*omega*" (also known as single scattering albedo) is normally considered to have a small constant value for a given frequency, incident angle, and polarization in microwave inversion algorithms. This assumption may be true for short and stationary vegetated terrain at L-band. However, considering that satellites in orbit collect microwave data all over the globe, one could expect that the large fraction of data in land is acquired over vegetation that can be spatially and temporally variant. Agricultural crops particularly change substantially from planting to harvest. It is thus expected that the constant albedo approach may not be appropriate over many types of vegetation. In addition, the small albedo assumption is not fully consistent with theory and ground observations for moderate and dense vegetation.

We have recently introduced a new "*effective scattering albedo*" concept that generalizes some of the restrictions imposed by the original *tau-omega* model. This new parameter explicitly incorporates complex scattering processes inside the vegetation canopy, and also at the vegetation–soil interface into the generalized *tau-omega* model. Since the new parameter involves multiple surface scattering and ground–vegetation interactions, the parameter depends on the ground conditions, unlike the restrictive single scattering albedo. Our previous investigations also indicated that the constant albedo may introduce a significant error in soil moisture values retrieved using the *tau–omega* over temporally varying vegetated terrains unless its dynamic nature is taken into account.

In this study, we apply the "*effective scattering albedo*" concept to microwave data recently collected by NASA's Combined Radar/Radiometer system (a ground-based simulator for NASA's Soil Moisture Active Passive (SMAP) mission) over corn and soybean fields for entire growing season in 2012. Ground truth data associated with vegetation and ground conditions were also acquired to verify microwave models under a controlled experimental setup. We invert the *effective scattering albedo* from the measured brightness temperature by utilizing knowledge of the transmissivity of the vegetation and reflectivity of the ground that are calculated from ground truth measurements. The main focus of the study is to investigate relationships between the *effective scattering albedo* and dynamic scene conditions such as growth stage of the vegetation and soil moisture.