Modifying Tau-Omega Model to Account for Forest Canopy Scattering

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Retrieving soil moisture from microwave brightness temperatures in the presence of vegetation has been the subject of much research in the past. Most microwave soil moisture retrieval algorithms for sensing soil moisture through a vegetation canopy have been developed at low microwave frequencies such as L band or 1.4 GHz. They have been based on a simplified zero-order radiative transfer approach called the tau-omega model. The model ignores scattering and simulates brightness temperatures of vegetation-covered surfaces as a function of soil emissivity, vegetation single scattering albedo, and vegetation opacity. Application of the tau-omega model to data acquired during airborne and ground-based campaigns over the years has solidified scientific understanding of microwave interactions with different landscapes. In particularly, shrubland, grasslands, agricultural crops, and light to moderate vegetation have been investigated. Further investigation is, however, required for assessing the suitability of this approach when applied to a forest canopy; here, scattering from branches and trunks are very important. In this study, the fundamentals of transport theory will be utilized to modify the tau-omega model to more accurately account for forest canopy scattering.

A tree canopy can be envisioned as a random collection of discrete scatterers. Given the average particle phase function, the density of scatterers, and the dielectric constant of the underlying ground, the transport equation in conjunction with discrete model can be solved for the radiated flux. The result is complicated and can be simplified substantially at L-band by retaining just the zeroth and first order terms in the transport theory. This formulation adds a new scattering term to the tau-omega model which represents radiation scattered from the trunks, branches, and leaves in the canopy. This additional term is complicated since it involves an integral over all directions of waves incident on the scatterers.

In this study, formulation of the modified tau-omega model that includes canopy scattering will be presented. Detailed ground truth data obtained during an experiment at Maryland in 2006 and 2007 will be used to compute the additional radiation due to scattering and emission by the vegetation components. The importance of this additional term to the tau-omega model will be evaluated for a forest canopy. Emphasis will be placed on examining how the radiometer response to soil moisture is modified by the forest canopy scattering.