# L Band Brightness Temperature from Forests: Comparison of Approximate Techniques

By Mehmet Kurum, Roger Lang, and Peggy O'Neill

In this paper, three approximate physical microwave radiometry models have been used to calculate brightness temperatures from a forest canopy at L-band. These models are (1) tau-omega model (zero order scattering approximation to radiative transfer equations), (2) successive order of scattering model up to first order (first order scattering approximation to the radiative transfer equations), and (3) Peak technique utilizing the active solution obtained from the Distorted Born Approximation (DBA). These models are physically-based and treat vegetation as a layer of discrete scatterers over a rough surface. Vegetation components within the canopy are represented by canonical shapes such as dielectric discs and cylinders.

The tau-omega model is based on a zero-order solution to the radiative transfer (RT) equations. The model ignores scattering except for the effect of the scatterers in the attenuation of the emission through the vegetation. 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 particular, shrubland, grasslands, agricultural crops, and light to moderate vegetation have been investigated. Its applicability to areas with a significant tree fraction is unknown.

The first order scattering model is based on an iterative solution of the RT equation up to the first order. The first order solution is obtained by substituting the zeroth-order solution into the scattering source term and then solving the resulting radiative transfer equations. This formulation adds a new scattering term to the tau-omega model. It represents emission by particles in the layer and emission by the ground that is scattered once by particles in the layer. The resulting model represents an improvement over the standard zero-order solution (the tau-omega model) since it accounts for the scattered vegetation and ground radiation that can have a pronounced effect on the observed brightness temperature.

The third model is based on the Peake formulation in conjunction with the DBA. The procedure for calculation of forest emission is accomplished by first calculating the bistatic scattering cross section for each type of scatterer, then by using the DBA to calculate specular albedo of the ground and the diffused albedo of the layer. Once the albedos are determined, Peake's principle relating active and passive problems can be used to determine the effective emissivity of the forest layer.

This paper compares the tau omega model, the first order scattering solution to the RT equation, and the Peake formulation used in conjunction with the DBA. The applicability of these models to determine the brightness temperature in areas with a significant tree fraction will be evaluated for L-band frequencies. Contributions of the individual scattering terms and their role in contributing to forest scattering will be identified, and their dependence on angle and soil moisture will be demonstrated. Comparison to experimental data from several tree stands will be given.

(1) ***Title of the paper***: L Band Brightness Temperature from Forest: Comparison of Approximate Techniques

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