

MODELING AND SIMULATION OF NEAR-EARTH WAVE PROPAGATION IN PRESENCE OF A TRUNCATED VEGETATION LAYER

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In our studies, we are currently in the process of assembling a physics-based propagation model to facilitate accurate prediction of signal path-loss among the nodes of an unattended ground sensor (UGS) network deployed in a natural environment. In a previous paper [Liao and Sarabandi, 2005], the problem of VHF wave propagation in the presence of a vegetated-terrain was treated by replacing the physical medium with an effective homogeneous two-layer medium and then applying the asymptotic dyadic Greens function to compute the radiated field distribution of an electric-dipole with the assumption that the vegetation layer is infinite in extent. In practice, the effects of any discontinuity in the vegetation layer would have to be included to accurately model the path loss between the transmitter and receiver. The geometry of a related canonical problem can be visualized if the vegetation layer is truncated in one of its two infinite dimensions in other words, in this modified problem, the ground is covered by a semi-infinite dielectric slab. An exact solution to this problem can be found through a full-wave numerical technique such as FDTD; however, for near-earth propagation problems in which the computational domain is large and the wave energy spreads out to the receiver at grazing-angles, a full-wave analysis is rather difficult to implement in an efficient and straight-forward manner.

To the best of our knowledge, the propagation effects of a truncated vegetation canopy have been analytically examined only by Tamir through a ray-tracing approach [Tamir, 1977]; while Tamir's solution is simple to construct, its accuracy has not been fully verified. In this work, we seek out to formulate a semi-exact, analytical solution to the same problem by making use of the equivalence principle; specifically, the field at an observation point located in the far field of a truncated vegetation canopy is solved by performing a surface-field integration over the vertical, fictitious 2-D plane containing the truncation facet. Since the solution contains limits of integration that are infinite, the stationary phase approximation is applied as needed to achieve computationally-efficient solutions. It is seen that for large receiver heights, a very efficient full 2-D stationary phase approximation can lead to accurate results; however, for an observation point located in the vicinity of the ground, in order to correctly capture the Norton waves emanating from the equivalent sources situated on the plane of integration close to the ground, the modified approach in the form of a 1-D stationary phase approximation augmented with numerical integration is more appropriate.

Liao, D.H., and K. Sarabandi (2005), Near-Earth Wave Propagation Characteristics of Electric Dipole in Presence of Vegetation or Snow Layer, *IEEE Trans. Antennas and Propagat.*, 53, page numbers not yet been assigned.

Tamir, T. (1977), Radio Wave Propagation Along Mixed Paths in Forest Environments, *IEEE Trans. Antennas and Propagat.*, 25, 471-477.

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