NEAR-EARTH WAVE PROPAGATION CHARACTERISTICS OF ELECTRIC DIPOLE IN PRESENCE OF VEGETATION OR SNOW LAYER

DaHan Liao, Kamal Sarabandi
Radiation Laboratory, Department of Electrical Engineering and Computer Science, The University of Michigan

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1. (a) DaHan Liao
3124 EECS
1301 Beal Ave.
Ann Arbor, MI
48109 USA
liaod@umich.edu

(b) 734-647-0750

(c)

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3. (a)

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The unrelenting quest for ever more robust communication networks has not only prompted the innovation of novel communication devices and signal processing algorithms but also has underscored the need for a more complete understanding of electromagnetic wave propagation in different environments. In this study emphasis is given to propagation in a setting defined by natural surface features and obstacles such as terrain roughness (large and small scale undulations), hills, rivers, and vegetations and snow layers. Such a setting is of significant interest in the design of unattended ground sensor networks. Since the heights of the transmitters and receivers in the network are low, there is a number of challenging problems in the propagation model that must be addressed and resolved through either analytical or numerical means or a hybrid combination of both.

In the current phase of the study, the radiation characteristics of an infinitesimal, arbitrarily-oriented electric dipole in the presence of a dielectrically-covered terrain is investigated with the use of a two-layer half-space model in which the middle layer represents vegetation or snow. In the near field region of the dipole, the field components can be calculated using numerical integration; however, due to the complexity of the integrand, calculations in the far field must be carried out analytically. Many studies have demonstrated the relevancy of the lateral wave for the case when both the transmitter and receiver are located within the dielectric medium and are separated by large distances. Unfortunately, for other configurations in which the transmitter or receiver (or both) is located above the dielectric layer, far field analytical expressions for all the electric field components do not exist; although generalized expressions can be found in literature, those expressions (often in terms of the scalar potential) are applicable only for a one-layer medium and have not been explicitly evaluated for a dipole source. In view of the aforementioned limitations, in this study a complete asymptotic evaluation for the electric fields of the electric dipole for arbitrary source and observation point locations is carried out through the method of steepest descents. Although the transmitter has been restricted to an electric dipole throughout the study, extension to an arbitrary antenna can be made by noting that the asymptotic form of the Greens function is related to the derived expressions for the field components by a simple constant. Therefore, the far field radiation of an arbitrary source can be easily computed numerically once its current distribution is known.