

The Undisturbed-Field Model: A Propagation Model for Close-In Distances and Very Low Antenna Heights

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This abstract describes a radio-wave propagation model (the Undisturbed-Field Model) that was developed at the Institute for Telecommunication Sciences (ITS). The Undisturbed-Field Model was developed as the result of an investigation to create a short-range mobile-to-mobile propagation model. ITS reviewed and evaluated currently available radio-wave propagation models and came to the conclusion that none of these models were suitable for addressing the requirements of ultra-short distances and very low antenna heights. The results of the work are available in an ITS report.¹ In this report, a deterministic method is described which is suitable for a very short-range propagation model for distances of 2 to 30 meters, antenna heights of 0 to 3 meters, and frequencies from 150 to 6000 MHz. The method involves the calculation of the undisturbed electric field and calculation of the loss based on the amplitude of the electric field as a function of distance, frequency, and the ground constants. The undisturbed field is that electric field produced by a transmitter antenna at different distances and heights above ground without any field-disturbing factors in the proximity of the receiver antenna location. This is in contrast to a disturbed field where an antenna located at the receiver site would disturb the electric field. The ITS report¹ describes the results in detail of an investigation of the differences between the undisturbed and disturbed (mutual coupling) methods of field computation, and goes on to show the differences between the results of propagation loss computed with both methods. The disturbed-field method is the more exact method, but it is more computationally intensive and difficult to calculate when compared to the relatively simple computations with undisturbed-field method. The ITS report shows via numerous examples that for most scenarios the difference between the propagation loss computed by undisturbed-field method and the disturbed-field method is minimal.¹ The undisturbed electric field technique includes near-field effects, the complex two-ray model, antenna heights, ground constants, antenna near-field and far-field response and the surface wave. Since this is a Line-of-Sight model, the ground is assumed to be flat over the distance of 30 meters or less with no irregular terrain present. For distances of less than 5 kilometers the curvature of the Earth has a negligible effect and can be assumed to be flat for frequencies less than 6 GHz over a smooth Earth.¹ The Undisturbed-Field Model should be used for distances less than 300 meters. It is particularly applicable for close-in distances less than 30 meters. This presentation will describe the development of the Undisturbed-Field Model and the methods that it uses for calculating propagation loss.

¹ N. DeMinco, "Propagation Loss Prediction Considerations for Close-in Distances and Low-Antenna Height Applications," NTIA Report TR-07-449, July 2007.