## Height Gain Functions for Radio-Wave Propagation Models

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This paper describes various forms of the height gain function that are used in radio-wave propagation models to account for the increase in path gain (reduction in path propagation loss) due to an increase in antenna height. There are different height gain functions depending on the particular scenario and the propagation model to be used for an analysis or system computation. Some propagation models implement the height gain function to fit the particular environment and geometry for the applications that they were intended for. Other propagation models need to have an appropriate height gain function added to properly compensate for the increase in path gain (reduction in path propagation loss). The height gain computation is a function of antenna heights, frequency, antenna impedance, antenna polarization, radiation pattern, terrain path, antenna type, and the ground constants. Height gain functions and computations also depend upon path length and when the path involves propagation by diffraction for either a spherical Earth or some other terrain feature or building obstruction. The path length and frequency will determine whether the Earth can be assumed to be flat over the entire propagation path, or if the presence of a smooth or an irregular Earth (with terrain) must be taken into consideration. There are both simple and complex methods for computing the height gain function. Numerous methods appear in the literature. The presentation will demonstrate several examples of height gain computations for different applications and environments. Classical methods will be discussed as well as approximations to these classical methods and where these approximations are valid. Simplified algorithms for these height gain functions will also be presented and their regions of validity.