Ground Wave Propagation over Complex Topography

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Surface-based non LOS communication in rural areas depends strongly on the wavelength, magnitude of the relief and ground electrical properties. We are investigating the seasonal non LOS propagation of 1- GHz signals over hilly terrain with tens of meters of relief using both field observations and 3-D numerical modeling. Our objectives are to compare the modeling and measured results of relative field intensity and wavefront direction to understand the dynamics of propagation over hills and onto plateaus. The surveyed conductivity and permittivity of our site appear fairly uniform. The vegetation is mainly grass, and the surface appears fairly smooth with limited, small-scale relief superimposed on the rolling hills we mapped with GPS. We located an omnidirectional transmitter antenna in a hidden valley, and used a directional receiver antenna to measure radiation directivity at several locations, both in summer and in winter with a heavy snow cover. For computational efficiency in our model volume ($\sim 10^6\,\mathrm{m}^3$), we have temporarily lowered the frequency to 100 MHz, lowered the relative permittivity (from 16 to 9), and simplified the topography. Our field results show that waves mostly arrive in the direction of the transmitter. 2-D slices in our 3-D modeling show that the waves creep rather than diffract over the smooth hill crests. The model valleys generate multiple events, and subsurface waves are also revealed. We are presently developing propagation over the full scale topography, the temporary results of which show large scale cylindrical spreading over the relief. However, it is the details within this general picture that we will compare with the field results.