

Wide Bandwidth Propagation, Part II: Multiple phase screen calculation of signal propagation through the ionosphere

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This is the second part of a two-part paper dealing with measurements and theory of propagation of wide bandwidth signals through the structured ionosphere. This part presents results from a two-dimensional multiple phase screen (MPS) calculation that computes numerical realizations or sample functions of the electric field after propagation through the ionosphere. The MPS code solves the parabolic wave equation and allows for direct computation of the received signal. The ionization is represented by a series of random phase screens that characterize the severity and spectrum of the electron density fluctuations. For wide bandwidth signals, the MPS code is exercised for many frequencies over the bandwidth of the propagating signal; Fourier transform techniques are used to obtain the propagating signal in the time domain.

The MPS simulation is quite general, and may be applied to problems involving numerous, separated, layers of ionization characterized by spatially varying electron density power spectra. MPS techniques can handle all levels of ionospheric disturbances from the least severe, where only small phase fluctuations occur, to the most severe case of frequency selective scintillation. Several animations of propagating signals are presented that simultaneously show the development of the ionospheric transfer function and the impulse response function.

The calculations are repeated and the realizations are averaged to obtain the two-frequency, two-position mutual coherence function, $\Gamma(f, x)$, which is compared to that obtained using strong-scattering theory.