Numerical calculations of electromagnetic wave propagation that solve the parabolic wave equation generally require that the propagation medium consist of a number of phase-changing screens. In general, the screens can be random, deterministic, or a combination. Deterministic shapes include Gaussian lenses, elongated Gaussian striations, and more complicated shapes. Statistically-based or random phase screens are usually generated using Fourier transform techniques where the phase of the screen is calculated as the FFT of the product of the square root of the desired power spectrum and white Gaussian noise. Although it is easy to show that these statistically-generated realizations have the desired PSD and autocorrelation function, the technique to generate them is more mathematical than physics-based. In this paper we consider two physically intuitive techniques to generate random realizations of phase-screens.

Consider the two-dimensional problem, where the ionospheric structure is infinitely elongated in the *y*-direction. Let the *z*-direction be the direction of EM signal propagation. This geometry represents propagation in the equatorial region of the earth where the magnetic field lines are elongated in the north-south direction. We assume that the ionization consists of a finite number of Gaussians with random locations in the *x*-*z* plane and with random radii. The size of each Gaussian is drawn from a user-chosen probability density function. This simple description is sufficient to allow us to generate numerical realizations of the disturbed 2D ionosphere. Furthermore, for this situation of Gaussians, we can analytically calculate the PSD of electron density fluctuations and the PSD and autocorrelation function of the phase of the phase-screens used to represent the ionosphere. This enables the comparison of the PSD of the numerical phase-screens to the analytic PSD calculated for a very large number of phase screens.

We show several examples of realizations of ionospheric structure calculated using Gaussians as the basic, underlying striation. Two different probability density functions for the striation size distribution are calculated and we calculate the resulting PSDs of electron density fluctuations for the case that there are a large number of striations. One yields a power-law of the form usually observed in the ionosphere. The other leads to a power-law form of the correlation function of in-situ ionospheric structure which is useful in conceptual studies.

We also consider the use of infinitely elongated vortex structures created by a flow with velocity shear. For these examples, the ionospheric region consists of a large number of similar flux-vortices that are randomly located within a fixed volume, filling the volume with non-overlapping structure. The collection of vortices can be directly converted to phase-screens through numerical integration. The PSD of the phase of the phase-screens can also be estimated numerically and used to generate statistically based realizations that give similar propagation results.

**References**

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