Scintillation Theory, Ionospheric Structure Characterization, and Global Models

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Abstract

Empirical models that predicted geographic, diurnal, seasonal, and solar-cycle dependent occurrence of VHF/UHF satellite beacon scintillation evolved from radio star and early satellite observations. Following the launch of the Wideband satellite in 1975, these models were improved to make quantitative predictions of frequency-dependent scintillation intensity and coherence. The WBMOD model became a U. S. Air Force standard. PBMOD extrapolated physics-based structure realizations to predict WBMOD scintillation intensity and coherence measures. These models and numerous other subsequent studies that interpreted in-situ and satellite beacon data characterize the ionospheric structure by a single or two-component inverse power-law variation of average the average wavenumber-resolved spectral intensity.

It is well known that the frequency dependence of scintillation intensity and coherence is acutely sensitive to power-law structure characteristics. However, only recently have strong-scatter theoretical calculations been refined to the point that the complete parameter space can be explored efficiently. Recent applications of the strong-scatter theory to ESF scintillation data show that the spectral characteristics change as the ESF structure evolves.

Recent analyses of C/NOFS satellite Langmiur probe data recorded over a four-year period have also revealed systematically changing ESF structure characteristics that we have associated with ESF evolution. This paper will present a quantitative summary analysis of the strong-scatter theory, the in-situ measurements, and the range of propagation disturbances that would be expected for propagation paths intercepting the structure. The C/NOFS data were acquired during low to moderate solar activity. The propagation theory allows us to anticipate GNSS propagation disturbances as more intense solar activity is encountered.