Ionospheric Irregularity Diagnostics: The Relative Contribution of Different Scale Lengths, in the Phase Structure Function Method for the Dynasonde

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Drift of the ionospheric plasma permits a radio-sounding signal to pass through different irregularities of electron density, even at only slightly different times. For a series of successive sounding pulses, this causes temporal phase variations which may be characterized statistically by the structure function. We have proposed (N. A. Zabotin and J. W. Wright, *Radio Sci*., **36**, 757-772, 2001) a new diagnostic method for ionospheric irregularities based on this effect, which is applicable to Dynasonde sounding data. In the present paper, we consider the range of the irregularity scales accessible by the phase structure function method. Our approach involves representation of the phase structure function as an integral over the irregularity spectrum; we can investigate numerically the contribution of different spectral bands into the integral. We show that for a two-dimensional irregularity power spectrum index $2 \lesssim \nu \lesssim 3$ (which is quite typical for ionospheric conditions), the phase structure function in the region of small temporal lags is sensitive to irregularities in a broad band of scales extending from several meters to several kilometers.

According to our analysis, small-scale irregularities are sufficiently represented in the ionosphere if the index ν of their power spatial spectrum $\Phi(\kappa_\perp) \propto \kappa_\perp^{-\nu}$ is less than three. In this case, a specific estimate for the minimum detectable scale length is given by the expression $L \simeq 2V\tau$, where V is the horizontal drift speed of the ionospheric layer and τ is the temporal lag of the phase structure function. In the opposite case ($\nu > 3$) where small-scale irregularities are very weak, advantage may be taken of a further result from our study, showing increased sensitivity for ray paths close to the direction of the geomagnetic field. This option is of practical value owing to the dynasonde's ability to measure the direction of arrival of ionospheric radio echoes.

We present our most recent results of the ionospheric irregularity diagnostics by the phase structure function method.