

Wide Bandwidth Propagation, Part I: Ionospheric Propagation Effects on Wide Bandwidth Signals

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This is the first part of a two-part paper that considers the scintillation of wide bandwidth signals that propagate through ionospheric irregularities. Scintillation consists of the rapid variation of signal phase, amplitude, angle-of-arrival, time-of-arrival and other signal properties. Any radar or communications system with transmission frequency from VHF through L-band and somewhat above that must operate through the ionosphere must be designed with consideration of its impact on the propagating signal.

It is well known that a propagating signal in this frequency range can experience disturbances due to naturally occurring F-region ionization. Depending on the radar or communications system location and requirements, different aspects of ionospheric propagation effects may be important. For example, a ground based radar that must operate at low elevation angles or long range must be designed with consideration of the effects of both ionospheric refraction and multipath. A wide bandwidth communications system at UHF may require different modulation types than a narrow-band system. Lines of sight that pass through equatorial or polar region irregularities are particularly vulnerable to scintillation.

This paper reviews several measurements of wide bandwidth propagation effects taken with ALTAIR (ABMDA Long-Range Tracking and Instrumentation Radar) in 1988 and 2005. ALTAIR directly measures two-way radar propagation through the tracking of orbiting calibration spheres. In 1988, ALTAIR measurements [1] provided the first observations of severe frequency selective scintillation from transionospheric propagation and also were the first to show the predicted enhancement in average power due to two-way ionospheric multipath. The 2005 measurements of Cannon et al., [2] resulted in the simultaneous characterization of time delay and Doppler, referred to as the generalized power spectrum. We also review the solution to the parabolic wave equation for spherical wave propagation and show that, in the limit of strong scattering, this solution is consistent with the ALTAIR measurements.

References

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