ESTIMATING THE IMPACTS OF IONOSPHERIC IRREGULARITIES ON SPACE RADAR DURING SOLAR MAXIMUM

K. M. Groves[1], S. Basu[2], T. Beach[1], C. S. Carrano[3], R. Caton[3], P. S. Cannon[4]

[1]*Air Force Research Laboratory, Hanscom AFB, USA*

[2]*Boston College, Newton, MA, USA*

[3]*AER, Inc., Lexington, MA, USA*

[4]*QinetiQ, Malvern, UK*

The partially ionized upper atmosphere can cause a variety of well-known propagation effects on VHF and UHF radio waves including refraction, polarization rotation, group delay, scattering, and phase and amplitude fluctuations. For radar applications utilizing trans-ionospheric ray paths, these effects may result in range and look-angle errors, multi-path, non-stationary clutter and Doppler and cross-section fluctuations. The severity of these effects and their potential impact on system performance are strongly dependent on ionospheric conditions, radar parameters and the specific application under consideration. Small-scale ionospheric electron density variations are of particular concern because of their causal association with rapid phase and amplitude variations known as scintillations. For systems operating in the VHF/UHF bands, amplitude scintillations can routinely exceed 10-20 dB in conjunction with phase scintillations of several radians. Moreover, these effects may vary non-uniformly across finite bandwidth waveforms causing substantial losses for pulse compression and coherent processing algorithms. The presentation will provide an overview of these effects derived from a combination of modeling and actual measurements, including extensive data collected with the ALTAIR VHF and UHF radars located at Kwajalein Atoll, Republic of the Marshall Islands. These data show a significant decrease in signal coherence time in the presence of even modest scintillation to a few tens of msecs with associated coherence bandwidths of less than one MHz. Far more substantial impacts are expected during solar maximum closer to the Appleton anomaly regions where global electron density peaks and large-scale instabilities generate a broad spectrum of irregularities. Results from data collected under these conditions will be applied to recently collected radar observations to estimate the magnitude of effects anticipated on space-radar systems during solar maximum. Specific applications, such as synthetic aperture radar imaging, will be considered.