Modeling ionospheric impacts on transionospheric signals with a phase screen constructed from radar phase-derived TEC

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Abstract

We use VHF/UHF ALTAIR radar tracking data from passive calibration spheres in low earth orbit (LEO) to demonstrate the validity of a one-dimensional phase screen model to represent the propagation channel through a disturbed ionosphere. We construct the 1-D phase screen from radar phase-derived estimates of the total electron content (TEC) and present a detailed comparison of the results with observed radar returns during disturbed and quiet conditions. *In-situ* density measurements from LEO satellites, such as C/NOFS, together with such a phase screen model will be use to drive scintillation specification products.

1. Summary

Severe scintillation on transionospheric radio signals caused by small-scale plasma irregularities can greatly disrupt wideband communication, surveillance, and navigation systems. Development of techniques to mitigate the effects of scintillation requires accurate characterization of the ionospheric propagation channel. To achieve this goal, multiple campaigns were conducted as part of the joint US-UK Wideband Ionospheric Distortion Experiment (WIDE) to obtain ionospheric signatures from various instruments at the Ronald Reagan Ballistic Missile Defense Test Site on the Kwajalein Atoll. We use VHF/UHF ALTAIR radar tracking data from passive calibration spheres in low earth orbit (LEO) to demonstrate the validity of a one-dimensional phase screen model to represent the propagation channel through a disturbed ionosphere. We construct the 1-D phase screen from radar phase-derived estimates of the total electron content (TEC). These estimates will be compared with incoherent scatter measurements of the ambient plasma by the ALTAIR radar. We present a detailed comparison of our modeled signal after propagation through the phase screen and the observed radar returns under both disturbed and quiet ionospheric conditions. We also compare these results with observations from other ground- and space-based instruments including GPS, SCINDA, and COSMIC. Successful reproduction of the radar amplitude fades represents a significant increase in our understanding of the small-scale plasma irregularities and represents a significant step towards the implementation of a space-based scintillation tool using *in-situ* density measurements from LEO satellites, such as C/NOFS, together with a phase screen model to accurately assess system impacts.