Modeling and Analysis of COSMIC Radio Occultation (RO) Scintillation Events

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The COSMIC satellite mission has provided continuous global GPS-to-LEO satellite observations that have advanced meteorological and ionospheric climatology. Whereas earth-based satellite beacon observations present angular scans, the RO links present nearly horizontal propagation paths within disturbed regions, which eliminates the ubiquitous phase screen model. Much of the complexity of RO geometries is suppressed by assuming radial variation of the primary structure. While this assumption evidently captures mean altitude dependence, ionospheric scintillation depends on the direction of the propagation path relative to the non-radial magnetic field. COSMIC ROs more often present uniform cross field propagation at high latitudes than at equatorial latitudes.

With these issues in mind, a study of highly disturbed COSMIC ROs has been undertaken. The standard SNR data archives present only 1-s link samples, but the propagation geometry is well resolved. Equatorial Spread F is of particular interest, and published COSMIC RO scintillation morphology. (http://www.agu.org/pubs/crossref/2010/2010JA015618.shtml) is consistent with prevailing theory. However, most of the ROs present propagation paths with flux-tube-aligned components. One expects systematic variation with the angle of the propagation paths relative to the magnetic meridian plane.

A fully three-dimensional model is conceivable, but beyond our current ability to characterize structures from hundreds of kilometers to hundreds of meters. Charles Carrano introduced a two-dimensional equivalence principle that effectively considers only two-dimensional structure in the principal propagation plane. (http://www.agu.org/pubs/crossref/2011/2010RS004591.shtml). Although the initial computations used a cross-field mapping, the more general approach is formally identical to parabolic-wave-equation models that are used for modeling propagation over oceans and/or terrain. Atmospheric ducting is replaced by flux-tube variations at higher altitudes. It is convenient to maintain the surface reflection capability to capture multipath. Preliminary results of the study and modeling will be presented.