Numerical Ray Tracing of GPS Radio Occultation Paths

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Numerical three dimensional ray tracing techniques are commonly used for calculating the path of an electromagnetic signal in a medium specified by a position dependent refractive index. In this study a three dimensional numerical ray technique, which traces finite flux or ray tubes, is used in conjunction with the IRI207 model. The IRI207 model contains many large scale ionosphere features where significant electron density gradients exist such as the sunrise and sunset terminators, the ionospheric layers and the equatorial anomaly. The presence of the earth's magnetic field on the ionosphere causes it to act as a birefringent medium on electromagnetic propagation. The effects of the earth's magnetic field on the transmitted signals and the paths of the ordinary and extraordinary signals are investigated. Both GPS L-Band frequency paths transmitted from the GPS to LEO satellites are simulated with a focus on signal paths traversing the atmosphere and ionosphere where the refractive gradients are greatest. The down range and transverse gradients on the GPS to LEO paths are investigated. The findings will highlight the importance of numerical ray tracing by identifying GPS to LEO paths where significant refraction and increased uncertainty in retrieved GPS signals occurs.