Ionospheric refraction on GNSS radio occultation signals

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Extended Abstract

Radio signals of Global Navigation Satellite Systems (GNSS) are refracted while travelling through the plasmasphere/ionosphere on its way to the receiver onboard a Low Earth Orbiting (LEO) satellite. Due to spatial gradients of the electron density distribution significant ray path bending is caused that depends on elevation angle and GNSS frequency. In case of radio occultation measurements, the signal received from a rising or setting satellite travels an extreme long distance through the ionosphere and hence experiences a significant ray path deviation from the straight line of sight (Los). We used a two dimensional ray tracing tool to trace signals from transmitting GNSS satellites down to receiving COSMIC satellites in limb sounding mode. Simulation studies have been done to determine the ray path bending error of GNSS occultation signals. Our analysis reveals that the ray path bending error, i.e., the excess path in addition to the geometric path length (LoS) or true range may exceed the 1 meter level for the GPS L2 signal when high total electron content is assumed [1, 2]. The corresponding deviations of the curved optical ray path from the straight LoS may exceed the 2 km level [1, 2]. In addition, we have found that the tangential heights (closest approach to Earth)) of the signal paths may deviate by more than 1 km from that of the straight LoS propagation. This might cause a substantial error in determining the reference height in the atmospheric profiles retrieval techniques. We believe that this knowledge is helpful to improve current atmospheric retrieval techniques.

References

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