



Ionospheric Electron Density Profiles from GOES Geostationary GPS Observations: Early Results and Validation

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We present the first results of application of GNSS Radio Occultation (RO) technique to data from GPS receivers at a geostationary orbit. The Geostationary Operational Environmental Satellites (GOES) are weather satellites that operationally contribute continuous remote-sensing data for real-time weather forecasting, as well as near Earth environment monitoring and Sun observations. The GPS receivers onboard GOES-16 (R) and GOES-17 (S) satellites can track GPS signals propagated through the Earth's atmosphere and can be used to estimate electron density profiles. But it is important to note that GOES GPS receivers were not designed to generate RO profiles—these receivers were designed as navigation receivers only. Together with the nontraditional geometry above the GPS constellation of transmitters and single frequency GPS L1 observations, this presents a number of unique challenges to the traditional RO signal processing algorithms.

We discuss the applied processing strategies and present first results for ionospheric RO retrievals from GOES-16 and GOES-17 GPS navigation receivers [1]. The processed dataset covers ~5 years for GOES-16 and ~3.5 years for GOES-17 satellite, respectively; over 10K RO EDPs within an altitudinal range of 100 – 1000 km were retrieved.

To assess performance of the GOES-based RO retrievals for ionospheric electron density profiles, we carried out direct and statistical comparison of the derived ionospheric F2 peak parameters (density and height) with the benchmark ionosonde observations that demonstrated a very good agreement between these two independent types of measurements. Additionally, we analyzed collocations in space and time with COSMIC-1 and COSMIC-2 RO retrievals, as well as GOES RO profiles performance by comparison with climatological values provided by the ionospheric empirical model International Reference Ionosphere (IRI-2020). We want to highlight that RO profiles from geosynchronous orbit hold the potential to generate unique temporal and spatial atmospheric measurements complementary to those from the ground and low Earth orbit (LEO) space-based receivers, including limb observations of the upper atmosphere at altitudes above traditional LEO RO satellites.

References

- [1] S. Gleason, I. Cherniak, I. Zakharenkova, D. Hunt et al., “The First Atmospheric Radio Occultation Profiles From a GPS Receiver in Geostationary Orbit,” *IEEE Geoscience and Remote Sensing Letters*, **19**, doi: 10.1109/LGRS.2022.3185828.