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GNSS Radio Occultation Prediction

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Global Navigation Satellite Systems (GNSS), such as GPS, have a crucial role in modern technologies by providing precise positioning, navigation, and timing information, while advancing remote sensing techniques [1]. Among these applications, GNSS Radio Occultation (GNSS-RO) stands out as an effective method for atmospheric observation. This technique uses GNSS signals as signals of opportunity, received by low-Earth orbiting (LEO) satellites, to extract atmospheric profiles. As the signal passes through the Earth's atmosphere, it experiences a refraction, resulting in bending along its path, as illustrated in Fig.1. The observed difference between the direct and measured bent path distances between the receiver and the GNSS satellite is expressed by the time series excess phase, a key RO observable [2]. While these effects are considered as errors in GNSS positioning, they are the primary focus in GNSS-RO, as they're used to derive the atmospheric refractivity profiles using the Abel inversion [3].

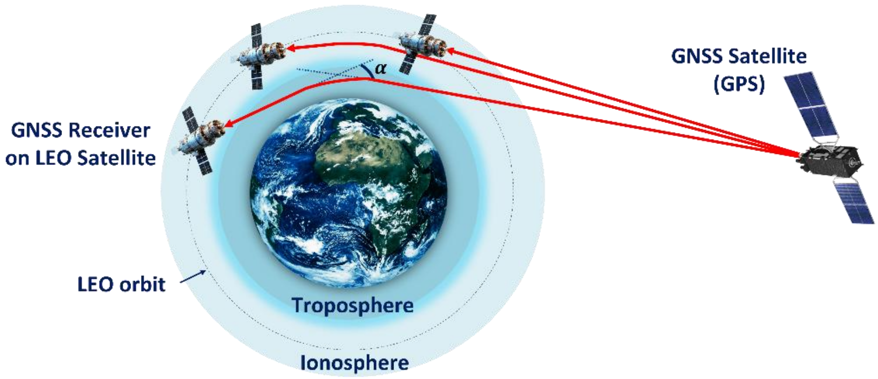

Figure 1 : GNSS Radio Occultation Principal

Since its first demonstration with the GPS/MET mission in 1995, GNSS-RO has advanced significantly, with missions like COSMIC-2 and MetOp contributing thousands of daily atmospheric profiles to global weather models. COSMIC-2 alone provides up to 5,000 soundings per day using GPS and Galileo signals [4]. However, despite these achievements, LEO-based GNSS-RO is limited in providing localized atmospheric soundings due to their orbital paths. While they offer global coverage, they cannot provide detailed local atmospheric measurements over specific regions at desired times.

Ground-based GNSS-RO offers an alternative for localized atmospheric observations, by installing fixed receivers that record occultations when satellites set behind the horizon, targeting localized measurements in the lower troposphere with sharp refractivity gradients. In this study, we develop an approach to accurately predict the start, end, and duration of GNSS occultation events for a stationary receiver. By activating the receiver exclusively during these occultation windows, the system efficiently minimizes energy consumption and data storage requirements.

Our results show that by predicting the start, end, and duration of occultation events, ground-based GNSS-RO receivers can record data exclusively during these predicted intervals, ensuring precise localized atmospheric profiles and thus enhancing regional weather forecasting and climate monitoring.

References :

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