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Ionospheric Refraction on GPS Signals Received Onboard LEO Satellites

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The bending of the ray-path of GNSS signals is caused by the ionospheric refractivity which mainly depends on the electron density distribution along the ray path. Bending effects lead to a deviation of the curved optical path from the straight line of sight (LoS). Due to the dispersive nature of the ionosphere GNSS signals at L1 and L2 frequencies travel along different ray paths through the ionosphere. In both cases the ray path is longer than the length of the LoS, in particular at low elevation angles at ground based receivers. The corresponding excess path in addition to the LoS or true range may achieve several centimeters at low elevations under high solar activity conditions. Radio occultation measurements onboard Low Earth Orbiting (LEO) satellites indicate ionospheric bending effects of the excess path up to the meter level. The corresponding errors in TEC estimates used for retrieving vertical electron density profiles from GPS radio occultation measurements are discussed. The computed deviations of the curved optical path from the straight LoS may reach the kilometer level. Consequently, the tangential heights of the signal paths at the closest point of approach to the Earth surface deviate from that defined by the straight LoS propagation. This may cause an error in determining the reference height in the retrieved vertical refractivity profiles.