Juno Radio Science Observations and Gravity Science Calibrations of Io Plasma Torus

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Interplanetary and Earth-ionosphere plasma electrons have significant impacts on radio frequency signal propagation such as telecommunication between spacecraft and the Deep Space Network (DSN). The Juno spacecraft's first closest approach of Jupiter (Perijove 1 on August 27, 2016) provided an opportunity to remotely sense plasma electrons inside of the Io plasma torus utilizing radio science measurements from Juno. Here, we report on the plasma electron content of the Io plasma torus derived by using two-way coherent radio science measurements made from Juno's Gravity Science Instrument and the Deep Space Network. During Perijove 1, the Juno spacecraft passed through the inner region (Perijove altitude of ~ 1.06 Jovian Radii) between Jupiter and the Io plasma torus. Significant plasma electron variations of up to ~30 Total Electron Content units (TECU, $\sim 10^{16}$) were observed while the radio link between Juno and the DSN traveled through the central regions of the Io plasma torus.

In this research, we compare observations made by open-loop and closed loop-processes using different frequency two-way coherent radio signals (Ka/Ka, X/Ka, X/X radio links), corresponding Io plasma torus model simulations, and other Earth ionosphere observations. The results of three-dimensional Io plasma torus model simulations are consistent with observations with some discrepancies. Additionally, we will present a comparison between Juno Radio Science observations and Io Plasma Torus model simulations form other Perijove passes. Results are shown to improve our understanding of the Io plasma torus effect on Juno gravity science measurements and its calibrations to reduce the corresponding (non-gravity field induced) radio frequency shift.