

Radio-Tomographic Images of Post-Midnight Equatorial Plasma Depletions

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For the first time, post-midnight Equatorial Plasma Depletions (EPDs) have been imaged in the longitude-altitude plane using radio-beacon tomography. High-resolution ($\sim 10 \text{ km} \times 10 \text{ km}$) electron-density reconstructions were created in the area between approximately -90° and -55° longitude near the geomagnetic equator. The reconstructions were created using Total Electron Content (TEC) measurements from an NRL receiver array sited in Peru and the MART inversion algorithm. TEC was derived from the 150 and 400 MHz signals transmitted by the CERTO beacon on the C/NOFS satellite. The MART algorithm requires an “initial guess” ionosphere, which was generated by using in-situ electron density data from the C/NOFS CINDI instrument and electron density profiles from an ionosonde operated by the University of Massachusetts at Lowell (UML). Each initial guess ionosphere was approximated below the F-peak by replicating an ionosonde profile over all longitudes within the imaging region; above the F-peak a Chapman function was fitted to the ionosonde F-peak density and the corresponding CINDI in-situ measurement at each longitude. In this study, EPDs spawned pre-midnight were imaged near dawn. Observed EPDs had widths of 100-1000 km, spacings of 300-900 km, and often appeared “pinched off” at the bottom. Well-developed EPDs appeared on an evening with a very small (4 m/s) Pre-Reversal-Enhancement (PRE), suggesting that postmidnight enhancements of the vertical plasma drift and/or seeding-induced uplifts (e.g. gravity waves) were responsible for driving the Rayleigh-Taylor Instability into the nonlinear regime on this night. On another night the Jicamarca incoherent scatter radar recorded postmidnight (~ 0230 LT) Eastward electric fields nearly twice as strong as the PRE fields seven hours earlier. These electric fields lifted the whole ionosphere, including embedded EPDs, over a longitude range $\sim 14^\circ$ wide. CINDI detected a dawn depletion in exactly the area where the reconstruction showed an uplifted EPD. Strong Equatorial Spread-F observed by the UML ionosonde during receiver observation times confirmed the presence of ionospheric irregularities.