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A New Technique for Measuring and Modeling Global D- and E-Region Electron Density with GPS-RO

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A novel retrieval technique is developed for electron density (Ne) in the D- and E-region (80-120 km) using the high-quality 50-Hz GPS radio occultation (GPS-RO) phase measurements [Wu, 2017 in JASTP]. The new algorithm assumes a slow, linear variation in the F-region background when the GPS-RO passes through the D- and E-region, and extracts the Ne profiles at 80-130 km from the phase advance signal caused by Ne. Unlike the conventional Abel function, the new "bottom-up" approach produces a sharp Ne weighting function in the lower ionosphere, allowing the E-region retrieval less affected by the F-region residuals. The retrieved Ne profiles are in good agreement with the IRI (International Reference Ionosphere) model in terms of monthly maps, zonal means and diurnal variations. The daytime GPS-RO Ne profiles can be well characterized by the Chapman function of three parameters (NmE, hmE and H), showing that the bottom of E-region is deepening and sharpening towards the summer pole. As a result, an empirical model is being developed for the background E-region Ne to capture the variations due to solar zenith angle and the solar 11-year cycle (Lyman-alpha index). The monthly Ne maps at high latitudes also reveal clear enhancement from auroral electron precipitation down to the 80-120 km altitudes. Strong tidal modulations of the E- and D-region electron density from the lower atmosphere are evident in the GPS-RO observations. The new Ne data now allow a joint investigation of the sporadic E (Es) occurrence in different E-region backgrounds. The layered (2-10 km) Es component has a smaller amplitude, approximately an order of magnitude lower than the mean background Ne. The GPS-RO E-region electron density measurements provide a new data source to study energetic electron precipitation (EEP) and its impacts on the upper atmosphere. It can also be used to evaluate influence of atmospheric forcings/processes, such as wave forcing and deep convective lightning, on the lower ionosphere.

See paper for more details:
http://www.sciencedirect.com/science/article/pii/S1364682617301050