Studying the Dynamics of Magnetosphere-Ionosphere (M-I) Coupling by Imaging the Plasma Density Structures of the Inner Magnetosphere

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Abstract: The global density structure of the inner magnetosphere can be monitored using a combination of techniques that use ground- and space-based Global Positioning System (GPS) receivers. Low-Earth-Orbit (LEO) satellites equipped with dual-band GPS receivers and the dramatically growing ground-based GPS receiver network offer an excellent opportunity for remote sensing and monitoring of the ionospheric and plasmaspheric density structure using GPS total electron content (TEC) tomographic reconstruction. This allows us to clearly quantify magnetosphere-ionosphere (M-I) coupling dynamics, which includes the long-standing conjecture that the mid-latitude trough and plasmapause are on the same field line. This has been demonstrated globally, for the first time, using combination of data from IMAGE EUV images and ground- and space-based GPS receivers. The two dimensional tomographic image of the ionosphere and plasmasphere provides a new ability to image the flux tube structure of ionospheric ion outflows, tracking flux tube structure up to *3.17Re* (20,200 km) altitude for the first time. Traditionally, ion outflow has been detected by using a single satellite cut over the field line at a certain altitude, however, the tomographic reconstruction approach can reveal the entire picture of the field aligned ion outflow emanating from the cusp region. This indicates that tomographic reconstruction techniques have the ability to detect narrow ionospheric ion outflows between the ionosphere and magnetosphere.