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Saturn's Periodic Magnetosphere: The Relation Between Periodic Hot Plasma Injections, a Rotating Partial Ring Current, Global Magnetic Field Distortions, Plasmapause Motion, and Radio Emissions

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It has been know for some time that the large-scale energetic particle injections (∼3-200 keV) on the nigh side of Saturn observed by Cassini/INCA are closely tracked by the periodic Saturn Kilometric Radiation (SKR). The resulting energetic particle pressure is comparable to that of the colder plasma and it therefore distorts the global magnetic field significantly as the energetic particle population drifts around Saturn. In this presentation we discuss the important consequences this has for the large-scale dynamics and configuration of the entire inner magnetosphere of Saturn. We begin by reviewing the observational correlations between remote, global INCA observations of energetic particles, magnetic field distortions, and radio emissions. We present examples of how the magnetic field measurements and the INCA observations show direct implications of a rotating 3D electrical current system associated with, not only, the energetic particle pressure, but also with an interhemispheric field-aligned current (FAC) system. Recently, we found an intriguing high correlation also between the periodic motion of the high-latitude plasmapause-like boundary reported by Gurnett et al. [2011] and the energetic particles observed remotely by INCA that are periodically injected on the night side and then drift around Saturn according to their energy. In our preliminary analysis we see a direct correlation in at least 75% of the case with the center of drifting energetic particle distribution [Brandt et al., 2010] and the encounter with the rotating plasmapause-like density boundary [Gurnett et al., 2011]. However, the remaining, low-correlation cases suggest that we do not fully understand the global, 3D current system that produces the periodic perturbations in Saturn's magnetosphere. We will use these observations to constrain the underlying 3D current system and in particular, assess the role of interhemispheric FACs in reproducing the observations.