Modeling of Inner Magnetosphere Coupling Processes

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The Ring Current (RC) is the biggest energy player in the inner magnetosphere. It is the source of free energy for Electromagnetic Ion Cyclotron (EMIC) wave excitation provided by a temperature anisotropy of RC ions, which develops naturally during inward convection from the plasmasheet. The cold plasmasphere, which is under the strong influence of the magnetospheric electric field, strongly mediates the RC-EMIC wave-particle-coupling process and ultimately becomes part of the particle and energy interplay. On the other hand, there is a strong influence of the RC on the inner magnetospheric electric and magnetic field configurations and these configurations, in turn, are important to RC dynamics. Therefore, one of the biggest needs for inner magnetospheric research is the continued progression toward a coupled, interconnected system with the inclusion of nonlinear feedback mechanisms between the plasma populations, the electric and magnetic fields, and plasma waves.

As we clearly demonstrated in our studies, EMIC waves strongly interact with electrons and ions of energies ranging from ~1 eV to ~10 MeV, and that these waves strongly affect the dynamics of resonant RC ions, thermal electrons and ions, and the outer RB relativistic electrons. As we found, the rate of ion and electron scattering/heating in the Earth's magnetosphere is not only controlled by the wave intensity-spatial-temporal distribution but also strongly depends on the spectral distribution of the wave power. The latter is also a function of the plasmaspheric heavy ion content, and the plasma density and temperature distributions along the magnetic field lines. The above discussion places RC-EMIC wave coupling dynamics in context with inner magnetospheric coupling processes and, ultimately, relates RC studies with plasmaspheric and Superthermal Electrons formation processes as well as with outer RB physics.