Plasmasphere Modeling with the SHIELDS Framework

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1. Extended Abstract

The Earth's plasmasphere, a region of cold dense plasma trapped in the inner magnetosphere, is typically eroded as geomagnetic activity increases during a storm, and then slowly refills during the storm recovery with a time scale of several days. The shape of the plasmasphere is mainly determined by the dynamics of the time-dependent convection electric field. The overall convection strength in the magnetosphere is driven by the solar wind, however, the near-Earth flow pattern is regulated by the ring current pressure gradient and the ionospheric conductivities. As part of the coupled inner magnetosphere system, the plasmasphere feeds back on ring current dynamics since energetic particles moving fast through the ambient plasma lose energy and are scattered by the thermal electrons and ions. The plasmasphere density and ion composition are also major controlling parameters for wave-particle interactions in the inner magnetosphere.

Global modeling is a powerful tool to determine the dominant processes for the formation of various plasmasphere features (density variations, plasmapause location, etc.). We present simulations with our ring current-atmosphere interactions model (RAM) two-way coupled with a 3-D equilibrium code (SCB) and a cold plasma model (CPL) [1] as part of the SHIELDS framework [2] developed at LANL. The RAM-SCB-CPL model calculates the cold electron density in the equatorial plane by following the motion of individual flux tubes, using an electric field model that includes a corotation potential and a choice of convection potential from a) semi-empirical models [3, 4, 5], or b) self-consistently calculated electric potential [6], mapped to the equatorial plane along SCB field lines. The RAM-SCB-CPL model is used to simulate plasmasphere dynamics during selected events and provides clues of how the plasmasphere is eroded and then refilled. Model results are compared to plasmasphere observations of electron densities and to other models [7, 8]. The plasmaspheric effects on inner magnetosphere dynamics and wave-particle interactions are discussed as well.

2. References

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