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Study of the inner magnetospheric response to pressure pulses in the solar wind based on the GEMSIS-RC model

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Geospace storms are the largest electromagnetic disturbance in near-Earth space and facilitate extensive particle acceleration in the inner magnetosphere, which causes development of the ring current and a drastic increase of relativistic electrons in the radiation belt. GEMSIS (Geospace Environment Modeling System for Integrated Studies) of STEL, Nagoya University, is the observation-based modeling project for understanding energy and mass transportation from the Sun to the Earth in the geospace environment. Aiming at understanding the dynamics of the inner magnetosphere during the geospace storms, the GEMSIS-Magnetosphere working team has addressed the development of new physics-based models for the global dynamics of the ring current (GEMSIS-RC model) and radiation belt (GEMSIS-RB model).

The GEMSIS-RC model is a self-consistent and kinetic numerical simulation code solving the five-dimensional collisionless drift-kinetic equation for the ring-current ions in the inner-magnetosphere coupled with Maxwell equations. It is demonstrated that the propagation of magnetohydrodynamic waves can successfully be described by the present model. It is also found that the self-consistent coupling could affect the transport of energetic particles especially at low energies as well as the intensity and spatial distribution of field-aligned currents. Our approach is unique in the sense that it includes MHD wave modes as well as deformation of magnetic field configuration due to the ring current self-consistently. In order to investigate responses of the inner magnetosphere to pressure pulses in the solar wind, time variation of magnetic and electric fields as well as the ring current ion distributions is simulated based on the GEMSIS-RC model with simple boundary conditions to mimic an abrupt compression of the inner magnetosphere. The effects of the pressure pulses on excitation of ULF waves, generation of FAC, and change in the pitch angle distribution of ring current ions will be discussed for several cases.

Keywords: inner magnetosphere, ULF waves, ring current, radiation belt, SC, solar wind dynamic pressure