Flux decrease of outer radiation belt electrons associated with solar wind pressure pulse:A Code coupling simulation

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Relativistic electron flux of the outer radiation belt dynamically changes in response to solar wind variations. Variations of solar wind cause the flux drop-out of the outer belt electrons. Magnetopause shadowing (MPS) has been proposed to cause rapid loss of relativistic electrons of the outer belt (e.g.,Kim et al.,2008). In general, it has been expected that MPS is a cross-field transportation due to convection and/or the dayside compression of the magnetosphere. However, the gyro-radius of relativistic electrons of the outer belt seems to be too small compared with the spatial scale of gradient of the dayside magnetopause to escape across the magnetopause. In this study, we investigate another escaping process of relativistic electrons into the interplanetary space. We conduct a code-coupling simulation of a test-particle simulation code (GEMSIS-RB: Saito et al., 2010) and a global MHD magnetosphere simulation code (GEMSIS-GM: Matsumoto et al., 2010). We calculate a number of trajectories of guiding-center of electrons in electromagnetic fields calculated from GEMSIS-GM. In the simulation, electrons are initially distributed from R_e = 6 to 11 with initial energies from 1 MeV to 10 MeV. Initial pitch angles of electrons are distributed from 50 degrees and 90 degrees. In this simulation, the solar wind dynamic pressure and the magnetopause stand-off distance change as follows; [i] The stand-off distance of the magnetopause is 12 R_e with the initial dynamic pressure of 1.0 nPa, B_{y_IMF} of 0.005 nT, B_{z_IMF} = 3.0 nT. [ii] The solar wind dynamic pressure increases to 2.5 nPa, and the magnetopause moves to 9 R_e . In this period, the pitch angle scattering of electrons with L value larger than 9.0 occurs by Drift Shell Bifurcation (DSB). [iii] The dynamic pressure decreases, and the inflation of the magnetopause takes place. The stand-off distance of the magnetopause moves back to 10 "R" _"E" . In this period, electrons with L value larger than 9.25 are scattered by DSB. During phase [ii], the high-latitude magnetic reconnections occur at dawn-side. Several electrons are scattered by DSB and the mirror points change to the high latitude where electrons can escape into the interplanetary magnetic field along the field line. During the periods, the high-latitude reconnections occur at the high-latitude in the dusk side. In phase [iii], the trapped electrons in the magnetosphere escape from the field lines that connect to the interplanetary magnetic field in both the dawn and dusk sides. The flux decreases are found in not only higher-L shell but also the lower L-shell, because ExB drift by the induced dawn-to-dusk electric fields cause the outward movement of relativistic electrons. As a result, some electrons move from closed magnetic field to open magnetic field, which cause the loss of trapped electrons in the lower L-shells at least L = 8.75 during the inflation of the magnetosphere. In our study, it is found that outward transport tends to occur at high energy, because electrons with large drift velocity observes dawn to dusk electric field for large periods. The study reveals some electrons at outer radiation belt escape to high latitude into the interplanetary magnetic field along the field line, which are different process from the traditional MPS.