Magnetic field dipolarization in the deep inner magnetosphere and its role in development of O+-rich ring current

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We studied magnetic field dipolarization and associated ion acceleration in the deep inner magnetosphere, using magnetic field data obtained by the magnetometer (MAM) onboard the Mission Demonstration Satellite -1 (MDS-1) satellite and the energetic neutral atom (ENA) flux data obtained by the high-energy neutral atom (HENA) imager onboard the Imager for Magnetopause-to-Aurora Global Exploration (IMAGE) satellite. Since the MDS-1 satellite has a geosynchronous transfer orbit, we could survey magnetic field variations at L=3.0-6.5. We analyzed data in the period from February to July in 2002. We found that (1) dipolarization can be detected over a wide range of L (i.e., L=3.5-6.5, which is far inside the geosynchronous altitude); (2) when the MDS-1 satellite was located close to auroral breakup longitude, the occurrence probability of dipolarization was about 50% just inside the geosynchronous altitude and about 16% at L=3.5-5.0, suggesting that dipolarization in the deep inner magnetosphere is not unusual; (3) magnetic storms were developing whenever dipolarization was found at L=3.5-5.0; (4) dipolarization was accompanied by magnetic field fluctuations having a characteristic timescale of 3-5 sec, which is comparable to the local gyroperiod of O^+ ions; and (5) after dipolarization, the oxygen ENA flux in the nightside ring current region was predominantly enhanced by a factor of 2-5 and stayed at an enhanced level for more than 1 hour, while clear enhancement was scarcely seen in the hydrogen ENA flux. From these results, we conjectured a scenario for generation of O^+-rich ring current, in which preexisting thermal O^+ ions in the outer plasmasphere (i.e., an oxygen torus known from satellite observations) experience local and nonadiabatic acceleration by magnetic field fluctuations that accompany dipolarization in the deep inner magnetosphere (L=3.5-5.0).