Study of the magnetic storm phase dependence of the inner boundary of the plasma sheet electrons

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The locations of inner boundary of the plasma sheet electrons during magnetic storm have been analyzed statistically by using THEMIS data. Plasma sheet electrons are carried toward the earth due to magnetospheric convection, and then drift toward the morning sector in the vicinity of the earth. Thus, the inner boundary of the plasma sheet electrons is formed at a geocentric distance around 3 - 7 R_E. The location of the inner boundary of the plasma sheet particles has been investigated as an indicator of the evolution of the plasma sheet particles, part of which causes ring current in the inner magnetosphere. In addition, plasma sheet electrons can precipitate along a magnetic field line, and produce aurora in the earth's ionosphere.

Previous studies investigated the dependence of the location of the inner boundary of the plasma sheet electrons on geomagnetic indices such as Kp and AE index [Korth et al., 1999; Jiang et al., 2011]. Jiang et al. [2011] reported the local time distribution of the inner boundary of the plasma sheet electrons in both quiet and disturbed conditions by referring AE index. In this study, we focus not only on dependences on Dst index but also on dependences on phase of magnetic storms. The data used in this study are obtained by Electrostatic Analyzer (ESA) onboard the THEMIS satellite. ESA measures the energy flux, density and temperature of particles over the energy range from a few eV to 30 keV for electrons and to 25 keV for ions. In the present study, 1 to 10 keV electrons measured by ESA was analyzed. First, we check a correlation between the position of inner edge and Dst index. In addition, the events in which we identified inner edge of the plasma sheet electrons are categorized into four groups : Type A (inner edges were identified when Dst $<$-30 nT during main phase), Type B (Dst $>$-30 nT during main phase), Type C (Dst $<$-30 nT during recovery phase) and Type D (Dst $>$-30 nT during recovery phase).

The result of the statistical study shows that the positions of the inner edge of the plasma sheet electrons depend on not only Dst index but also the magnetic storm phase. Comparing Type A with Type C and Type B with Type D, we find in the main phase of the magnetic storm that the identified inner boundaries of the plasma sheet electrons with energy of 1 keV and 9 keV are located around the similar radial distance. On the other hand, in the recovery phase of the magnetic storm, we find that the inner boundaries of the low energy electrons (˜1 keV) is closer to the earth than that of the high energy electron (˜9 keV).

Finally, we compared the locations of the inner edge of the plasma sheet electrons obtained by ESA onboard THEMIS satellite with those estimated based on the steady state drift boundary model using Volland-Stern electric field as proposed by Jiang et al. [2011]. We could confirm that the steady state drift boundary model is a good approximation in the main phase of the magnetic storm. On the other hand, we found that the model does not agree with the position of the plasma sheet electrons in the recovery phase of the magnetic storm. The disagreement is clearer for 1-keV electrons than for 10-keV electrons. So, the test particle simulation including the evolution of electric field will be need in order to confirm how the location of plasma sheet electrons varies in the storm time inner magnetosphere.