THEMIS衛星の観測に基づくプラズマシート電子地球側境界の磁気嵐フェイズ依存性に関する研究
Study of the magnetic storm phase dependence of the inner boundary of the plasma sheet electrons based on THEMIS satellites observations

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The locations of the inner boundary of the plasma sheet electrons during magnetic storm have been analyzed by using the dataset from THEMIS satellites. 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. The location of the inner boundary of the plasma sheet particles has been investigated as an indicator of the variations of the drift path of the plasma sheet particles, part of which causes ring current in the inner magnetosphere.

In several previous studies, the dependence of the location of the inner boundary of the plasma sheet electrons on geomagnetic indices such as Kp and AE index was investigated [Korth et al., 1999; Jiang et al., 2011]. In this study, we investigated the dependences of the plasma sheet electrons not only on geomagnetic indices such as Dst index but also on the phase of magnetic storms.

In order to investigate the relation between the dynamics of the plasma sheet electrons and the magnetospheric convection electric field, we focused on the position of the inner edges of the plasma sheet electron during the main phase and the recovery phase of the magnetic storm by using the electron flux data in an energy range from 0.7 keV to 9 keV obtained by Electrostatic Analyzer (ESA) onboard the THEMIS satellites.

As a result of event studies and statistical analyses, we found that the dependences of the plasma sheet electron inner edge on Dst index in the main phase and the recovery phase of the magnetic storm were different: Even if the Dst index is in the same range, the plasma sheet electron inner edges identified in the main phase were significantly nearer to the Earth than in the recovery phase of the magnetic storm. In addition, we could point out that the gap between the locations of the inner edges of 1 keV electrons and 9 keV electrons became smaller in the main phase than in the recovery phase of the magnetic storm. These results suggest that the position of the plasma sheet electron inner edges are affected by the electric field which appears around the peak of the magnetic storm and cause the modification of drift paths of plasma sheet electrons to be nearer to the Earth, and to be similar without depending on the electron's kinetic energy.

In order to confirm how the difference between the location of the plasma sheet electron inner edges in the main phase and that in the recovery phase occurs, we performed comparison of the locations of the plasma sheet inner edges found in several cases with those estimated based on the steady state drift boundary model [Jiang et al., 2011] combined with Volland-Stern electric field model [Volland et al., 1973]. This comparison suggested that the steady state drift boundary model cannot fully explain the positions of the inner edges of the plasma sheet electrons. In addition, we could point out that the gap of the positions of the inner edges of 1 keV electrons and 9 keV electrons derived from the observations became smaller than that estimated based on the model. These results suggest that some electric fields are added to Volland-Stern large-scale electric field in the observation, which can cause the modification of drift paths of plasma sheet electrons to be nearer to the Earth, and to be similar without depending on the electron's kinetic energy.

And in order to confirm whether the small-scale strong electric fields reported by Nishimura et al. [2006], we performed back-tracing of the drift paths of plasma sheet electrons during the recovery phase of the magnetic storm using the test particle simulation. As a result, we could suggests that the actual open/close boundary of the drift path of the electrons with energy of 9 keV indicated by their inner edge was located nearer to the Earth than that expected based on Volland-Stern electric field due to the additional electric field.

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