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On the electron temperature variation in the plasmasphere during the magnetic storm

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We present the electron temperature observation in the plasmasphere from thermal electron energy distribution instrument on Akebono satellite. The temperature data accumulated for 11 years exhibits a dynamic feature inside the plasmasphere, which was considered as less variable compared to the trough or higher latitude regions, and it suggests that there exists thermal energy transfer between the plasmasphere and the ionosphere below and the magnetosphere above. In the present analysis, the electron temperature variation during the magnetic storm is analyzed to investigate the thermal energy income and outgo in the main or recovery phase.

Only a limited number of the electron temperature data in the mid-altitude (>4000 km) plasmasphere are available in the literature because of unreliable measurements on low-density plasma condition. The thermal electron energy distribution (TED) instrument onboard Akebono satellite can overcome the difficulties and has been providing a great amount of data in the plasmasphere from 1000 to 10000 km altitudes.

The electron temperature in the ionosphere and plasmasphere is one of the important parameters to consider thermal energy transfer to the external regions. In particular, the temperature variation during a magnetic storm has attracted a great deal of considerable attention, from a viewpoint of the ionospheric response to the external conditions. Numerous theoretical and observational studies on the temperature variation during the storm in the trough and higher-latitude ionosphere have been carried out for a long time, because these regions are connected with a region of ring current whose magnitude changes with a progress of the magnetic storm. However, little attention was paid to that in the low and mid latitude inner plasmasphere that is not considered as so influential by the ring current variation.

The electron temperature data from Akebono observations for 11 years since the satellite launch are used to study the plasmasphere, and it is found that the plasmaspheric electron temperature exhibits a dynamic behavior during the magnetic storm. This suggests that there exists thermal energy transfer between the plasmasphere and the ionosphere below or the magnetosphere above. In the present analysis, the electron temperature variation during the big magnetic storm (delta-Dst > 100 nT) is analyzed to investigate the thermal energy income and outgo in the main or recovery phase. Main conclusions of the present analysis are summarized as follows:

1) In the plasmasphere, heat flux along the magnetic-field lines from higher altitudes increases during the magnetic storm, and it results in an increase of the electron temperature.

2) The electron temperature increase caused by the heat flux variation is observed to exist in the inner plasmasphere (L=1.3-1.5) as well as in the vicinity of the plasmapause.

3) It is suggested that the heat source exists at higher altitudes, because the increment in the electron temperature positively correlates with the altitude.

4) A positive correlation between delta-Dst and the electron temperature increment is confirmed to exist; the increment becomes larger for a bigger storm.

5) From a comparison with NOAA satellite data, it can be concluded that the electron temperature increase is significant when a particle flux in the energy range from 30 keV to 80 keV becomes larger.

From these analyses, we conclude that the inner plasmasphere is also greatly influenced by the ring current variation during the magnetic storm. The characteristic feature of the plasmaspheric electron temperature disclosed by the present analysis is in contrast to the general behavior of the plasmasphere believed before.