Mass-dependent Ion Acceleration in the Plasma Sheet at Storm-time and Non-storm-time Substorms

Yumi Ono[1]; Masahito Nose[2]; Daisuke Nagata[3]; Stephen P. Christon[4]
[1] Earth and Planetary Sci., Kyoto Univ.; [2] DACGSM, Kyoto Univ.; [3] Dept. of Geophysics, Kyoto Univ.; [4] Focused Analysis and Research

It is well known that the flux and energy density of energetic ions increase in the near-Earth plasma sheet during substorm associated dipolarizations. Some studies have focused on the mass dependence of the ion flux increases and found that the flux and energy density of O^+ ions are more enhanced than those of H^+ ions. They have suggested that O^+ ions are accelerated non-adiabatically during dipolarization because the O^+ ion gyro-period is comparable to the time-scale of the magnetic field variations.

Whereas these earlier studies used just a few events for analysis, we analyze 95 events from 10-years of data (from 1995 to 2004) collected by the Energetic Particles and Ion Composition/ Suprathermal Ion Composition Spectrometer (EPIC/STICS) on board the Geotail spacecraft, which measures 9-210 keV/e ions. We compare the rate of O^+ ion energy density before and after a substorm onset to that of H^+ ion energy density. We find that, for 9-36 keV/e ions, the rate of O^+ energy density increase is larger than that of H^+. However, there is no sharp difference between the two rates for 55-210 keV/e O^+ and H^+ ions. In order to examine whether O^+ ions are accelerated non-adiabatically or not, we compare the gyro-period of O^+ ions (T_p) to the time-scale of the magnetic field variation (T_m) generated by substorm associated dipolarization. If they were close, the ions should be accelerated non-adiabatically. However, since T_m is found to be much larger than T_p in most of the events, we conclude that dipolarization cannot accelerate O^+ ions non-adiabatically and that previous studies observe rare events.

We then separate our events into two groups, storm-time substorms and non-storm-time substorms, and perform the same analysis independently in each group. The main results are as follows: (1) The increasing rate of O^+ with respect to that of H^+ is generally larger during non-storm-time than during the storm-time. (2) The increasing rate of the O^+ energy density in the dusk side of the plasma sheet is larger than that in the dawn side during the non-storm-time. (3) The energy density of low energy O^+ ions increases in the dawn side but decreases in the dusk side during the storm-time.