ABSTRACTS (MASTER THESIS)

Research on rapid increases of oxygen ion flux in the inner magnetosphere during the substorms

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Many charged particles are trapped in the magnetosphere where the Earth's dipolar magnetic field dominates the external magnetic field. Plasma population and flux are dramatically changed during magnetic storms and substorms. Rapid enhancements of energetic ions during a substorm are one of the unsolved issues in the inner magnetospheric research (< 7 Re). Previously, two distinct processes have been suggested to explain the enhancements. The first one is transport from the near-earth plasma sheet, and the other one is local acceleration. To test the both process, we performed test particle simulation under the electric and magnetic fields that are self-consistently obtained by the global MHD simulation developed by Tanaka et al. [1].

We released oxygen ions in tail region with an interval of 1 minute. The distribution function in the lobe is assumed to be drifting Maxwellian. The temperature is assumed to be 10 eV, the density is 10^5 m^{-3}, and the parallel velocity is given by the MHD simulation. In total, a few hundreds of millions of particles are traced. Each test particle carries the real number of particles in accordance with the Liouville theorem. After tracing particles, we reconstructed 6-dimensional phase space density of the oxygen ions, as well as the directional differential number flux using the phase space mapping so as to be able to make a direct comparison with in-situ satellite observations.

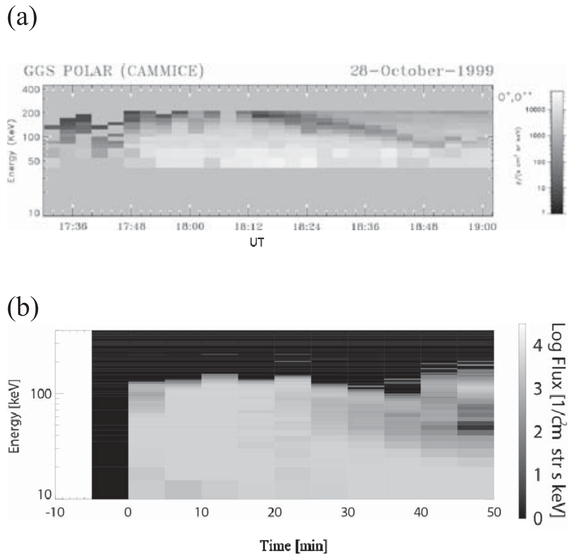

Figure 1. Energy versus time spectrograms of differential flux of energetic oxygen ions (a) observed by the Polar satellite, and (b) reconstructed by our simulation.

Just after a substorm onset, the differential flux of the ions is rapidly enhanced in the energy range from 50 to 150 keV at radial distance R greater than 7 on the nightside in the equatorial plane. The region of the enhanced flux propagates duskward, then to dayside because of grad-B and curvature drift of the ions. We also plotted energy versus time spectrograms of the differential flux at a fixed position, and compared with the Polar satellite observation (Figure 1). At 7.2 Re and at 22.4 MLT, the ion flux is suddenly enhanced about 10 minutes after the onset. The enhancement appears first at 120 keV, followed by lower energy as time proceeds. After a while, a high energy ion flux appears first, followed by that at lower energies. This is a called a drift echo, arising from the ions that encircled the Earth by the grad-B and curvature drift.

We successfully simulated the similar energy-time dispersion observed by Polar, and investigated the transport and acceleration processes and the dependence of the flux on the source distribution function.

References

[1] Tanaka, T., A. Nakamizo, A. Yoshikawa, S Fujita, H. Shinagawa, H. Shimizu, T. Kikuchi, and K. K. Hashimoto, "Substorm convection and current system deduced from the global simulation", *J. Geophys. Res*. 115, A05220, doi:10.1029/JA014676, 2010.