Large-amplitude electric fields and particle accelaration related to substorm: THEMIS event study

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Large-amplitude electric fields have been observed with earthward plasma flows in the near-Earth plasma sheet. It is important to observe both electromagnetic fields and particle distribution functions simultaneously in this region in order to understand the source of the large-amplitude electric fields. However, simultaneous observations of electromagnetic fields and particles in the plasma sheet have not been performed with a high time resolution which is comparable to the duration of large-amplitude electric fields (˜0.1 sec). The THEMIS probes simultaneously measure electromagnetic fields and particles with such a high time resolution. THEMIS also allow us to investigate the large-scale structure owing to conjunctions of the five probes. We will present simultaneous observation data of large-amplitude electric fields and particle acceleration in the Earth's magnetosphere from THEMIS. A substorm, which was identified by ground magnetometer data, occurred at 1:30 UT on 7 February 2008. During this substorm, TH-A ((X, Y) ˜(-7.2, 3.6) Re), D ((X, Y) ˜(-9.1, 3.2) Re), and E ((X, Y) ˜(-7.5, 3.8) Re), which were located close to each other, observed electric field spikes whose amplitudes were greater than 100 mV/m. These electric field spikes were associated with magnetic dipolarizations and earthward ion flows. The electron distribution function was dominated by the field-aligned component. This change of the electron distribution function associated with the large-amplitude electric fields indicates that electrons were heated in the direction parallel to the magnetic field. Next, we investigated the correlation of density and pressure to the electric field spikes. The electric field and spacecraft potential data indicate that large-amplitude electric fields were closely related to depletion of background electron density. In addition, the decrease in plasma pressure, resulting from density depletion, corresponded to the increase in magnetic pressure. The region where the electric field spikes were detected has diamagnetic nature. Because the electric field spikes and density depletion were observed at TH-A, D, and E locations with some interval, the series of electric field spikes can be regarded as a spatial structure. If we assume that the velocity of the structure is equal to the ion velocity, we can estimate the size of the large-scale structure from the average ion velocity and duration time of the large-amplitude electric fields. Since the average ion velocity was ˜300 km/sec and the duration was ˜100 sec, we conclude that this structure had a size of ˜4.7 Re. In addition, the electric field spikes were observed by TH-E ˜2 sec earlier than the observation by TH-A. Taking into account this interval, the ion velocity, and magnetic field data, the inclination of the structure with respect to the magnetic field line was 2-5 degrees. These results suggest that the shape of the large-scale structure was almost field-aligned, moving toward the Earth. These results are obtained for the first time by the THEMIS probes, which have the advantage of simultaneous multi-point observations of particles and fields with a high time resolution. However, since these results are based only on one event study, multi-event studies are required.