Statistical study of variations of ion composition in the plasma sheet during substorms: Geotail/EPIC observations

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There are various ion species in the plasma sheet: O+ and He+ ions are of ionospheric origin and He2+ ions are of solar wind origin. It has been reported by previous studies that the energetic ion flux of O+ increases more strongly than that of H+ in the plasma sheet during substorm activity because of acceleration associated with magnetic reconnection or local dipolarization. Most of these studies examined only a few substorm onsets, and there are few statistical studies.

This study statistically examines increases in the differential flux of H+ and O+ ions to find the acceleration mechanisms of these ions. We use data collected by the energetic particles and ion composition (EPIC) instrument on board the GEOTAIL spacecraft. This instrument accumulated 11-years of data (from 1995 to 2005) in the near-Earth region. Substorm onsets were identified by an increase in the longitudinally asymmetric (ASY) disturbance index, which describes the geomagnetic disturbance fields in mid-latitudes.

We have found substorm events showing a clear enhancement of energetic ion flux and a magnetic field disturbance. In some events there was no significant difference in the flux enhancement between H+ and O+ ions, while the other events showed a larger increase in the O+ ion flux than that in the H+ ion flux. We will discuss what causes these two different types of events. We will also examine if there is a difference in the flux enhancement between storm-time substorms and non storm-time substorms.