Dynamics of ions of ionospheric origin during magnetic storms: Their acceleration mechanism and transport path to ring current

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We investigated the spatial and temporal properties of the ion composition in the near-Earth plasma sheet (at geocentric distance, r, of 8-15 Re), using energetic (9-210 keV/e) ion flux data acquired by the suprathermal ion composition spectrometer (STICS) sensor of the energetic particle and ion composition (EPIC) instrument onboard the Geotail spacecraft. We analyzed data covering 8.3 years to find the MLT-r distribution of the H+, He+, and O+ energy densities (as well as the He+/H+ and O+/H+ energy density ratios) as a function of the SYM-H index. We obtained the following results: (1) The energy density increases as SYM-H decreases; (2) The energy density change depends on ion mass: the largest change occurs in O+ and the smallest change occurs in H+; (3) The energy density shows a dawn-dusk asymmetry when SYM-H is less than -50 nT, being larger on the duskside than on the dawnside; and (4) The He+/H+ and O+/H+ energy density ratios in the plasma sheet are similar to those in the ring current. From these results we conclude that ionospheric He+ and O+ ions are transported to the plasma sheet, accelerated there by the dawn-to-dusk electric field in a mass-dependent manner (heavier ions acquire more energy than lighter ions), and injected into the ring current region. Both the ion flux from the ionosphere and the energy gain in the plasma sheet become large when the geomagnetic disturbance becomes intense.