

## Closure of ionospheric and field-aligned currents in a substorm auroral bulge

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The large-scale closure of ionospheric and field-aligned currents is examined in detail on the basis of simultaneous observations of satellites and ground magnetometers for a moderate substorm. The primary substorm activity was initiated with onset of a rapid expansion of auroral bulge in both the poleward and azimuthal directions at 12:32 UT, which was monitored by the Visible Imaging System (VIS) onboard the Polar spacecraft. Following the primary expansion, the secondary activation was marked by westward traveling surges around the poleward edge of the bulge. During the second activity, the magnetogram at Kotel'nyy of magnetic latitude (Mlat) of  $\sim 70$  deg at premidnight recorded a continued evolution of the westward electrojet, while an enhancement of the northward and vertically-upward components of the magnetic field was observed at Tixie (Mlat  $\sim 66$  deg), indicating that the effect of the eastward electrojet flowing at lower latitudes dominated that of the westward one. The existence of the eastward electrojet below Mlat  $\sim 66$  deg is also supported by the poleward electric field observed by the Fast Auroral SnapshoT (FAST) satellite traversing the auroral bulge at MLT  $\sim 22$ h in the north-south direction. A detailed examination of the magnetic field data by FAST shows that the region of the poleward electric field is connected to the upward field-aligned current on the higher latitude portion and to the downward current on the lower latitude portion. It is also shown that there was a region of very weak electric field and field-aligned current on the higher latitude side of the eastward electrojet. This fact implies that the eastward electrojet with a pair of field-aligned currents is separated from the surge region in terms of the current closure. In addition, the simultaneous observation by one of the Defense Meteorological Satellite Program (DMSP) shows that the eastward electrojet at MLT  $\sim 20$ h was significantly larger than that at the FAST position. The difference in magnitude of the electrojet suggests that the eastward electrojet decayed as it flew from DMSP to FAST, possibly due to the upward field-aligned current somewhere between the two satellites.