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Global distributions of storm-time ionospheric currents as seen in geomagnetic field variations

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To investigate temporal and spatial evolution of global geomagnetic field variations from high-latitude to the equator during geomagnetic storms, we analyzed ground geomagnetic field disturbances from high latitudes to the magnetic equator. The daytime ionospheric equivalent current during the storm main phase showed that twin-vortex ionospheric currents driven by the Region 1 field-aligned currents (R1 FACs) are intensified significantly and expand to the low-latitude region of ˜30 degrees magnetic latitude. Centers of the currents were located around 70 and 65 degrees in the morning and afternoon, respectively. Corresponding to intensification of the R1 FACs, an enhancement of the eastward/westward equatorial electrojet occurred at the daytime/nighttime dip equator. This signature suggests that the enhanced convection electric field penetrates to both the daytime and nighttime equator. During the recovery phase, the daytime equivalent current showed that two new pairs of twin vortices, which are different from two-cell ionospheric currents driven by the R1 FACs, appear in the polar cap and mid latitude. The former led to enhanced northward Bz (NBZ) FACs driven by lobe reconnection tailward of the cusps, owing to the northward interplanetary magnetic field (IMF). The latter was generated by enhanced Region 2 field-aligned currents (R2 FACs). Associated with these magnetic field variations in the mid-latitudes and polar cap, the equatorial magnetic field variation showed a strongly negative signature, produced by the westward equatorial electrojet current caused by the dusk-to-dawn electric field.

Keywords: geomagnetic storm, convection electric field, shielding electric field, ionospheric disturbance dynamo, interplanetary magnetic field, solar wind