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Response of the convection electric field on the IMF southward tuning

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We have investigated the response of the convection electric field in the inner magnetosphere on the southward turning of the interplanetary magnetic field (IMF), and the spatial structure of the storm-time electric field using the CRRES spacecraft data. When the southward turning of IMF to -20 nT was measured by IMP-8 twice at 3:12 and 5:52 UT, which was accompanied by a storm with the minimum SYM-H of -216 nT, the CRRES spacecraft was located in the inner magnetosphere at 15 MLT and detected enhancements of the convection electric field at 3:13.5 and 5:56.5 UT. By considering the propagation time of the solar wind to the magnetopause at 10 RE (90 sec), the convection electric field in the inner magnetosphere increases within 3 min after the southward IMF Bz reaches the dayside magnetopause. The ambient magnetic field began to decrease simultaneous with the enhancement of the convection electric field, and the H component of the ground magnetic field at high latitudes in the dusk increases at the same time. These results indicate that plasma convection in the inner magnetosphere as well as ionospheric convection quickly responds to the energy input from the solar wind to the magnetosphere and the convection electric field enhances the ring current simultaneously.

The CRRES spacecraft flew through the inner magnetosphere around 15 MLT again from 12 to 15 UT during the main and early recovery phases of the storm. The convection electric field intensified between 3 and 6 RE with a magnitude of ~2.5 mV/m, while the amplitude of the electric field was less than 0.5 mV/m above L=6 and the intensity remained as the same level of the electric field during quiet times. The shielding electric field directed from dusk to dawn developed below L=3. The boundary between the convection and shielding electric fields correspond to the inner edge of the ring current inferred from the sharp gradient of the Z component of the magnetic field. The positive charge is accumulated at the inner edge of the ring current and acts as a source of the shielding electric field even during the main phase of geomagnetic storms. The region of the small electric field above L=6 corresponds to the plasmasheet as identified by measurements of low-energy particles. These results indicate that the convection electric field during storms enhances at a limited region between the earthward edges of the ring current and plasmasheet. The inner edges of the plasmasheet and ring current corresponds where the ring and tail currents are converted to the region 1 and 2 field-aligned currents, and the electric charge accumulated these locations can be the source of the convection electric field localized in the inner magnetosphere.