

Electric field and currents in the ionosphere-ground circuit during space weather disturbances

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When the CME or CIR hit the magnetosphere, the electric field and currents are generated by the dynamos in the magnetosphere and transmitted to the polar ionosphere down the magnetic field lines and further to the low latitude ionosphere. The transmitted electric field drives the Hall currents that close with themselves in the high-midlatitude ionosphere and the field-aligned currents close with the Pedersen currents that extend to the equatorial ionosphere near-instantaneously, where the Pedersen currents are intensified considerably by the Cowling effect appearing as the equatorial electrojet (EEJ). Thus, the geomagnetic disturbances often appear concurrently at high latitudes and the dayside equator with magnitude decreasing with latitude but amplified at the equator. At midlatitudes, the electric fields transmitted from high latitude are detected with the HF Doppler sounder, which are well correlated with the EEJ. The concurrent development of the midlatitude electric field and EEJ is commonly observed during the storm sudden commencements (SC), geomagnetic PC and Pi pulsations, quasi-periodic DP2 and storm/substorm convection and overshielding events. As shown in this paper, disturbances in the GIC (geomagnetically induced currents) on the ground are also well correlated with the EEJ and electric field in the ionosphere. The observations suggest that the electric current flows from the dynamo in the magnetosphere into the ground via the ionosphere. The ionospheric currents and GIC are connected by the displacement currents flowing on the wave front of the TM0 (TEM) mode waves propagating in the Earth-ionosphere waveguide (ionosphere-ground transmission line) [Kikuchi, 2014], where the Poynting flux is transported in the neutral atmosphere between the ionosphere and ground.