Response of the incompressible ionosphere to the compression of the magnetosphere during the geomagnetic sudden commencements

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The ionospheric plasma in midlatitude moves upward/downward during the geomagnetic sudden commencement causing the HF Doppler frequency changes; SCF (+ -) and (- +) on the day- and night-sides, respectively, except for the SCF (+ -) in the evening as found by Kikuchi et al.[1985]. Although the preliminary and main frequency deviations (PFD, MFD) of the SCF have been attributed to the dusk-to-dawn and dawn-to-dusk potential electric fields, there still remain questions if the positive PFD can be caused by the compressional magnetohydrodynamic (MHD) wave and what causes the evening anomaly of the SCF. With the HF Doppler sounder, we show that the dayside ionosphere moves upward toward the sun during the main impulse (MI) of the SC, when the compressional wave is supposed to push the ionosphere downward. The motion of the ionosphere is shown to be correlated with the equatorial electrojet (EEJ), matching the potential electric field transmitted with the ionospheric currents from the polar ionosphere. We confirmed that the electric field of the compressional wave is severely suppressed by the conducting ionosphere and reproduced the SC electric fields using the global MHD simulation in which the potential solver is employed. The model calculations well reproduced the PI and MI electric fields and their evening anomaly. It is suggested that the electric potential is transmitted from the polar ionosphere to the equator by the TM_0 mode waves in the Earth-ionosphere waveguide. The near-instantaneous transmission of the electric potential leads to instantaneous global response of the incompressible ionosphere.

Keywords: Incompressible ionosphere, geomagnetic sudden commencement, TM0 mode wave, ionospheric current, potential electric field

