How electric and magnetic fields change with solar wind variation during SC

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The sudden increase of the dynamic pressure of the solar wind (Psw) causes a sudden increase of the geomagnetic field especially in the low-latitude region. It is called geomagnetic sudden commencement (SC). The disturbance field SC is divided into two component [Araki, 1977 and 1987].

Dsc = DL + DP,

where DL represents a step-function like increase of the H-component dominant at low latitudes. It is caused by the current circuit flowing on the magnetopause and the propagating compressional wave. DP shows the two pulse structure dominant at high latitudes due to the polar ionospheric electric field.

DP = DP_{PI} + DP_{MI},

Preliminary impulse (PI) and following main impulse (MI) are caused by the dusk-to-dawn and dawn-to-dusk electric fields, respectively. These electric fields are believed to penetrate into the polar ionosphere from the magnetosphere [Tamao, 1964 ; Araki, 1994], and travel instantaneously to the low-latitude ionosphere [Kikuchi *et al.*, 1978 ; Kikuchi and Araki, 1979]. However, the SC-associated electric fields in the low-latitude ionosphere are not yet sufficiently clarified, and the effect of interplanetary magnetic field (IMF) on SC variations on the ground is not established.

In order to measure ionospheric electric fields, we have constructed an FM-CW radar (HF radar) at Sasaguri, Fukuoka (geomagnetic latitude=23.2 degree, geomagnetic longitude=199.6 degree). The FM-CW radar observation started in November, 2002. By using the doppler mode of FM-CW radar, we can detect a vertical drift velocity (v) of the ionosphere and its altitude with 10 seconds sampling. The ionospheric electric field E is derived by the relational expression of $\mathbf{E} = -\mathbf{v} \times \mathbf{B}$. Where the IGRF model is used to estimate magnetic field (B) at Sasaguri. From the above relation, we can measure the ionospheric electric field in the east-west direction. So we can observe short-period phenomenon of electric fields penetrating from the magnetosphere into the low-latitude ionosphere.

We analyzed 40 SC events that are recorded by a magnetometer at KUJ (G.M. Lat=23.6 degree, G.M.Lon=203.2 degree) and the FM-CW radar during the period from 2002 to 2005. The magnetometer station is part of the CPMN array [Yumoto and the CPMN Group, 2001]. At first, we compared the MI electric field with the magnetic field at the time of SC (MI). We found a positive correlation (correlation coefficient=0.70) between the MI electric and magnetic fields. We also compared the MI electric fields with changes in the Psw at the time of interplanetary shock event. There was a weak correlation (correlation coefficient=0.65) between them. On the other hand, no correlation was found between the electric field of the solar wind (Esw) and the MI electric field. The ionospheric MI electric field seems to depend mainly on the Psw.

In the next step, we analyzed 2 PI events that occurred around 14 h local time at Sasaguri. May 9, 2003 event occurred under the southward IMF condition, while the other February 18, 2003 event occurred under the northward IMF. From this comparison, we found that the PI electric field became weak under the southward IMF condition in the low-latitude region. It seems that the southward IMF reduces the intensity of the ionospheric PI electric field. As a result, preliminary reverse impulse (PRI) is not easily detected in the dip equatorial region during the period of southward IMF.