Estimation of the geomagnetically induced currents in Hokkaido with the two-layer model during major geomagnetic storms

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The geomagnetic induced current (GIC) measured at Memambetsu in Hokkaido, Japan (35.7 GM Lat) has been shown to be well correlated with the y-component magnetic field (By) observed close to the GIC station with correlation coefficients > 0.8, while poor correlations with Bx,z and dBx,y,z/dt (Watari et al., SW 2009). We have shown that the good correlation with By is valid for the SC and Pi2 with short periods (cc > 0.9), but it is poor (cc < 0.6) for substorm and storm with longer periods (Kikuchi et al., JpGU 2019). We have further shown that the GIC is proportional to the electric field, Ex, induced by By as calculated with the two-layer model for both short and long periods of disturbances (cc > 0.9). The model consists of highly conductive upper layer and less conductive semi-infinite lower layer. The strong By/Ex dependence of the Hokkaido GIC raises several issues: (1) How strong is the GIC estimated during past major storms? (2) What kind of space weather disturbances cause strong By? (3) Is the two-layer model applicable to GIC at other locations, and (4) What is the mechanism of the strong By dependence? The present paper focuses on the issue (1), presenting estimated GICs for the past major storms. With the observed and estimated GICs, we will discuss strong local time dependence of the GIC in correspondence to the development of field-aligned currents as well as ionospheric currents.

Keywords: Geomagnetically induced current, magnetic By component, field-aligned current, ionospheric current, geomagnetic storm

