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Evaluation of the earth-induced current contribution for a precise prediction of the Dst index

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A precise prediction of the Dst index is one of the important issues in space weather forecasting. The Dst index was developed by Sugiura [1964] to measure the magnitude of the axially symmetric geomagnetic field variations. The field variations during geomagnetic storms are produced by various currents in the magnetosphere, such as, the ring current, the tail current, the magnetopause current, and the field-aligned current. Since the Earth can be considered as a conductor, these magnetospheric currents generate the induced currents inside the Earth, which also contribute to the Dst index. Previous studies have reported that the magnetic field variations due to the induced currents are about 20-30% of the Dst index [Rikitake and Sato, 1957; Anderssen and Seneta, 1969; Langel and Estes, 1985; Hakkinen et al., 2002].

In order to predict the Dst index precisely, we need a more proper evaluation of the contribution of the Earth-induced current. From the property of induction, we expect that the percentage of the Earth-induced current contribution may depend on the rate of change of the disturbance field. Thus, using the magnetic field data obtained at 70-80 ground observatories, we examine how the Earth-induced current contribution changes during magnetic storms. The magnetic field variations are decomposed into portions of the external (i.e., magnetospheric current) origin and the internal (i.e., Earth-induced current) origin by using the spherical harmonic expansion. It is found that the Earth-induced current contribution varies between ˜30% and ˜50%. We will derive an empirical equation relating the Earth-induced current contribution to the rate of change of the disturbance field.