Statistical Features of Substorm Indicators during Magnetic Storms

Dae-Young Lee, K. W. Min, J. A. Hwang
Korea Advanced Institute of Science and Technology

This work reports statistical features of how two substorm indicators, magnetic dipolarization and energetic particle injection at the geosynchronous orbit, evolve during the storms. The storm Dst index is divided into three phases: Main phase, early recovery phase, and late recovery phase. Two separate sets of data are used for each of the indicators: GOES spacecraft data for the magnetic dipolarization and LANL spacecraft data for the particle injection. Both substorm indicators show remarkably common features as follows. (1) The occurrence frequency is highest during the main phase, decreases substantially during the early recovery phase, and further reduces through the late recovery phase. (2) The occurrence frequency is significant over wide LT sectors during the main phase while it becomes more and more centered around the midnight for the early and late recovery phases. (3) Many of both indicators during the main phase occur with small time delays with respect to the ground bay onsets, and the occurrence of such events are seen over wide LT sectors. In contrast, most of the events during the early and late recovery phases exhibit the longitudinal propagation pattern across the LT sectors: The farther an event from the midnight sector, the longer its delay. (4) The intensities of both indicators are biggest during the main phase, and remain still comparable during the early recovery phase, but substantially reduce through the late recovery phase. On the other hand, the short-term intensity of the dispersionless injections is more significant at higher energy channels during the main and early recovery phases, but it becomes prominent only at lower energy channels during the late recovery phase. All these results show that the three phases of the storms are clearly distinguished in terms of the substorm features. Also, the remarkable similarity between the two substorm indicators in the statistical result implies that majority of the geosynchronous injections, at least in the present data set, come from the substorm dipolarization process.