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Magnetic Field and Plasma Responses in the Near-Earth Magnetotail and Magnetospheric Boundary Layer During an Encounter of Heliospheric Current Sheet

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We examined responses for the magnetic field and plasma in the dawn and duskside near-earth magnetotail regions and magnetospheric boundary layer due to an encounter of Heliospheric Current Sheet (HCS) indicated as a sharp discontinuity in the B_x component of the Interplanetary Magnetic Field (IMF) without striking variation of the solar wind dynamic pressure and the polarity change of the IMF-B_z component. In this study, the magnetic field and plasma data obtained from THEMIS, Cluster, GOES-11 and -12 to investigate the magnetic field and plasma responses in the near-earth magnetotail region and magnetospheric boundary layer, and those taken from ACE and GEOTAIL to monitor associated solar wind conditions are utilized. Simultaneous geomagnetic field variations at high-latitude ground observatories were also examined. When HCS encountered with the magnetosphere, THEMIS-D, -E and -A observed the abrupt and transient magnetic field and plasma variations in the dawnside near-earth magnetotail, but the aspects and duration for these variations observed by between THEMIS-D, -E and -A were totally different. Although Cluster was oppositely located in the duskside magnetotail, only much smaller magnetic field perturbations were seen. Simultaneous enhancement of the north-south magnetic field component (B_z) associated with dipolarization, and negative bay variations accompanied by the Pi 2 waves were observed by GOES-11, -12, which were located at the pre-midnight and pre-dawn sectors, respectively, and the ground observatories. THEMIS-C, which was located in the magnetosheath just adjacent to the dawnside magnetopause and near THEMIS-A, experienced the single and multiple magnetopause crossings. This result indicates that the magnetopause surface waves were generated, although simultaneous solar wind conditions had been stable. Compared the magnetic field variations of THEMIS-A with those of THEMIS-C, the peaks of the abrupt and transient magnetic field variations observed by THEMIS-A were almost consistent with the magnetic field variation levels of THEMIS-C. Based on these observational results, it suggests that the abrupt and transient magnetic field and plasma variations observed by THEMIS-D and -E were direct phenomena caused by substorm, and those by THEMIS-A and the single and multiple magnetopause crossings experienced by THEMIS-C were caused by the magnetopause undulations due to substorm-associated inner-magnetospheric configuration changes. Furthermore, this substorm due to an encounter of HCS occurred locally because the magnetic field and plasma variations observed by THEMIS were localized upon the dawnside near-earth magnetotail region and their durations were also short-lived. The results obtained through this study emphasize that clear disturbances in the inner-magnetosphere can be brought by only one solar wind parameter's striking variation, although the solar wind conditions do not have significant variations that will make the magnetospheric condition change dramatically, such as an abrupt or long-term variation of the solar wind dynamic pressure, and an encounter of the impulsive or large southward (northward) IMF-B_z structure.