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S-M-I coupling during the super storm on November 20-21, 2003

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A super storm that occurred on November 20-21, 2003 is the second largest storm in terms of the Dst index (min.Dst: -472nT). In this period, variety of solar-terrestrial data is available from space and ground. We have studied how the S-M-I coupling drives magnetospheric convection and the geomagnetic storm during the November 2003 event. It is clarified that the magnetospheric convection is highly saturated during this event. The cross-polar cap potential (CPCP) estimated with Siscoe-Hill model by using the ACE solar wind data and the empirical conductivity model, is consistent with those estimated with the PC index. However, CPCP from ACE data is significantly overestimated during the first half of the storm main phase.

In contrast to the variations of the CPCP, the variations of the geomagnetic storm represented by of the Dst index develops linearly even during this extreme event. Injection rate of the solar wind energy (Q) estimated with O'Brien's empirical model by using ACE data corresponds with those estimated with Dst. However, the peak time of Q from solar wind data is two hour ahead of those from Dst.

We examine the properties of the magnetic field in the magnetosheath during this event by using GOES satellite data when the satellite is in the magnetosheath. During the first half of the storm main phase, it is found that the intensity of the magnetic field in the magnetosheath is small relative to those in the second half of the storm main phase, even though the ACE spacecraft observed almost the same magnitude of magnetic field in the upstream region during the storm main phase. We also find that the detailed variation in CPCP and Q during the first half of the main phase reproduced well with the magnetic field variations in the magnetosheath, not in the upstream region. It is suggested that the weakening of the magnetosheath field during the first half of the main phase occurs due to the decrease of Alfven Mach number below 2 within the intense magnetic cloud. We conclude that the S-M-I coupling works in different manners for the magnetospheric convection and the Dst variation. It is implied that the compression rate of the magnetosheath field, which depends on the local Alfven Mach number in the solar wind structure, is crucial for controlling the S-M-I coupling.

Keywords: S-M-I coupling, magnetospheric convection, geomagnetic storm, Alfven Mach number, magnetosheath