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Final Report Covering October 1973 - April 1975

on

National Aeronautics and Space Administration

Grant NGR-06-004-123

Grant Title: A Study of Geomagnetic Storms

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Final Report NASA Grant NGR-06-004-123

We have carried out the study of the initial phase of the geomagnetic storm by using interplanetary magnetic field and plasma data from Explorer series satellites. Twenty-one geomagnetic storm events during 1966-70 have been studied by using simultaneous interplanetary magnetic field and plasma parameters. Explorer 33 and 35 field and plasma data have been analyzed on large-scale (hourly) and small-scale (3 min.) during the time interval coincident with the initial phase of the geomagnetic storms. The principal results show that the solar-ecliptic B_z component turns southward at the end of the initial phase, thus triggering the main phase decrease in Dst geomagnetic field. When the B_z is already negative, its value becomes further negative. The B_y component also shows large fluctuations along with B_z. When there are no clear changes in the B_z component, the B_y shows abrupt changes at the main phase onset. On the small-scale behavior of the magnetic field and electric field ($\vec{E}=-\vec{V}x\vec{B}$) studied in details for the three events, it is found that the field fluctuations in B_y, B_z and E_y and E_z are present in the initial phase. These fluctuations become larger just before the main phase of the storm begins. In the large-scale behavior field remains quiet because the small-scale variations are averaged out. The power spectrum analysis for few events using 5.2 s data show the steepening of the spectrum after the shock wave associated with ssc. It appears that large as well as small time-scale fluctuations in the interplanetary field and plasma help to change the internal electromagnetic state of the magnetosphere so that a ring current could start causing a geomagnetic storm decrease.

Preliminary results were presented at the IAGA assembly in Kyoto, Japan[1] and the final results are published in a technical report of the University of Denver.[2]

1. V. L. Patel and M. J. Wiskershen, IAGA Bulletin No. 34, 175, 1973.
2. V. L. Patel and M. J. Wiskershen, Univ. of Denv. Dept. of Physics Tech. Report # 7515, 1975.

INITIAL PHASE OF GEOMAGNETIC STORMS AND INTERPLANETARY FIELDS AND PLASMA PARAMETERS

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Interplanetary magnetic field variations have been studied for 25 geomagnetic storms during a period of 1966-1970. Hourly values of the interplanetary field components in solar-ecliptic coordinates: Bx, By, Bz are compared with the hourly Dst index representing storm variations. In most of these events Bz is found to be southward near the beginning of the main phase of the storms. However, there are events in which By component becomes more important than Bz component in correlation with Dst during initial and main phases of the storms. We have further examined Ex, Ey and Ez components of the interplanetary electric field $\vec{E} = -\vec{V} \times \vec{B}$ where V is plasma velocity. Detailed analysis of three geomagnetic storms show that both Ey and Ez components have effects on Dst near the main phase. Further analysis using 3 min. averages shows large and rapid fluctuations in the interplanetary electric field components during initial phase of the geomagnetic storms. For these three storm events (Feb. 7, 15-16, 1967; Feb. 10, 1968) detailed analysis of the interplanetary conditions represented by Bx, By, Bz, Ex, Ey, Ez and dE/dt for the time intervals corresponding to the initial phase of the storms will be discussed.

ABSTRACT

Twenty-one geomagnetic storm events during 1966-70 have been studied by using simultaneous interplanetary magnetic field and plasma parameters. Explorer 33 and 35 field and plasma data have been analyzed on large-scale (hourly) and small-scale (3 min.) during the time interval coincident with the initial phase of the geomagnetic storms. The solar-ecliptic B_z component turns southward at the end of the initial phase, thus triggering the main phase decrease in Dst geomagnetic field. When the B_z is already negative, its value becomes further negative. The B_y component also shows large fluctuations along with B_z. When there are no clear changes in the B_z component, the B_y shows abrupt changes at the main phase onet. On the small-scale behavior of the magnetic field and electric field ($E=-VxB$) studied in details for the three events, it is found that the field fluctuations in B_y, B_z and E_y and E_z are present in the initial phase. These fluctuations become larger just before the main phase of the storm begins. In the large-scale behavior field remains quiet because the small-scale variations are averaged out. The power spectrum analysis for few events using 5·2 data show the steepening of the spectrum after the shock wave associated with the passage of ssc. It appears that large as well as small time-scale fluctuations in the interplanetary field and plasma help to alter the internal electromagnetic state of the magnetosphere so that a ring current could start causing a geomagnetic storm decrease.