Geosynchronous magnetic field variations associated with storm-time substorms

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Geosynchronous magnetic field variations associated with storm-time substorms have been studied using data from the GOES 8 geosynchronous satellite (GGLong.=-75deg., GMLat.=11deg.) in 1996-2001. We have used the data in the PEN coordinate system: In this coordinate system, Hp is nearly parallel to the Earth's spin axis, He is perpendicular to Hp and directed earthward, and Hn is perpendicular to both Hp and He and is directed eastward. First, we have identified possible magnetic field dipolarizations with the criterion that the field inclination, defined as arctan(Hp/He), increases by 5 degrees within 10 minutes. Next, we have checked ground magnetic field data observed at the low-latitude CPMN stations: A simultaneous observation of a Pi2 magnetic pulsation or a positive bay is required so that each of the above-identified possible event is kept as a true dipolarization. As a result of the above procedure, a total of 381 dipolarization events have been selected.

A statistical study of these 381 events shows that, in storm-time substorms (Dst less than -50nT), different types of magnetic field variations are observed at the geosynchronous altitude. First, westward (eastward) magnetic field perturbations are often observed in the premidnight (postmidnight) sector. This local time dependence is opposite to that of isolated substorms (Dst greater than -50nT). Second, the geosynchronous magnetic field magnitude increases before the dipolarization onset time, and decreases after the onset time; this pattern is the same as that observed in the tail lobe in isolated substorms. Third, the peak value in the above pattern, during storms, is much larger than the typical geosynchronous field strength (100nT).

In storm-time substorms, the inner edge of the plasma sheet approaches the Earth closer than the geosynchronous orbit. During the growth phase in storm-time substorms, plasma and magnetic pressure forces are balanced in the z direction at nightside geosynchronous orbit. During the expansion phase, plasma around the geosynchronous orbit is injected earthward and thus the plasma pressure decreases at the geosynchronous orbit. This means that the (frozen-in) magnetic field lines around the geosynchronous orbit are also accumulated to a more-earthward midnight region. Consistent with this idea is the observational result that, in storm-time substorms, westward (eastward) magnetic field perturbations are often observed in the premidnight (postmidnight) sector and the geosynchronous magnetic field magnitude decreases after the dipolarization onset. It is concluded that, in these substorms, the start point of dipolarization is located earthward of the geosynchronous altitude.

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