

Geotail observations of signatures in the near-Earth magnetotail for the extremely intense substorms of the 30 October 2003 storm

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Two coronal mass ejections associated with the X17 and X10 solar flares reached the Earth's environment at very high speeds on 29 and 30 October 2003, respectively, causing very intense geomagnetic storms ($Dst \sim -400$ nT). The present study focused on the main phase of the 30 October storm during which the Geotail spacecraft passed the near-Earth magnetotail at $X \sim 8$ Re. A number of extremely intense substorms occurred during this period. The intensity of the westward auroral electrojet exceeded 3000 nT in one of these substorms. The energetic particle observations from the low-altitude, polar-orbiting NOAA satellites indicate that the auroral oval shifted equatorward to magnetic latitudes much lower than usual, as low as 50 deg. Throughout the interval, the magnetic field and the plasma density in the near-Earth magnetotail were much larger than usual, suggesting considerable degree of energy accumulation in the lobe region and compression of the plasma sheet, and very intense cross-tail currents. The dense plasma may be responsible for the intense auroral electrojet and the intense ring current. Very large, rapid dipolarizations occurred in relation to the intense substorms. High-energy particle fluxes were an order of magnitude higher than usual, and their increases took place immediately after the dipolarizations. Fast tailward flows with large southward magnetic fields as well as fluxes of energetic heavy ions (oxygen) were also observed, suggesting that the magnetic reconnection took place in the near-Earth magnetotail, associated with the very intense substorms. This location is much closer to the Earth than usual.