AOGS 2006

Cutoff Latitudes of Solar Protons Related with Ring Current Proton Precipitation During Geomagnetic Storms: NOAA/POES Multi-Observations

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Solar energetic particles are injected into the Earth's magnetosphere but do not reach the inner magnetosphere connected to the low-latitudes by the field lines, based on the well-known Stormer theorem. Geomagnetic cutoff rigidity and cutoff latitudes of energetic particles have been investigated in the past studies and are reported to be controlled by the geomagnetic activities (Obayashi 1961, Fluckiger et al.1990, Leske et al.2001, Smart and Shea 2001, 2005, Birch et al.2005, etc.). Since July 2002, the polar orbiting NOAA/POES satellites (N15, N16, N17, and newly N18) have observed particles in a wide range of local time at altitudes of about 850 km. The onboard radiation monitors detect solar energetic protons (16 - 500 MeV). We have analyzed the combined data from the three or four satellites with time resolution of 1.5 hours which is near the orbital period of about 100 min in order to investigate local time dependences. The observations show that the cutoff latitudes (L-values) change accompanying with the phases of geomagnetic storms. In particular, during the big November 2004 storms with the minimum Dst of -380 nT, the cutoff L-values were correlated with the Kp index better than the Dst index. The cutoff latitude in the nightside sector was about 5 degrees lower than those in the dayside sector. It is found in comparison with the other particles that the solar proton cutoff changes with the inner edge of precipitating ring current protons (30 - 80 keV), and that the latitudinal difference between the solar proton cutoff and the outer edge of the outer radiation belt identified from electrons (0.3 - 2.5 MeV) becomes larger in the recovery phase than in the main phase because of the fast diffusion of the electrons.