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RELATIVISTIC ELECTRON PRECIPITATION NEAR THE OUTER BOUNDARY OF THE RADIATION BELT (EXTENDED ABSTRACT)

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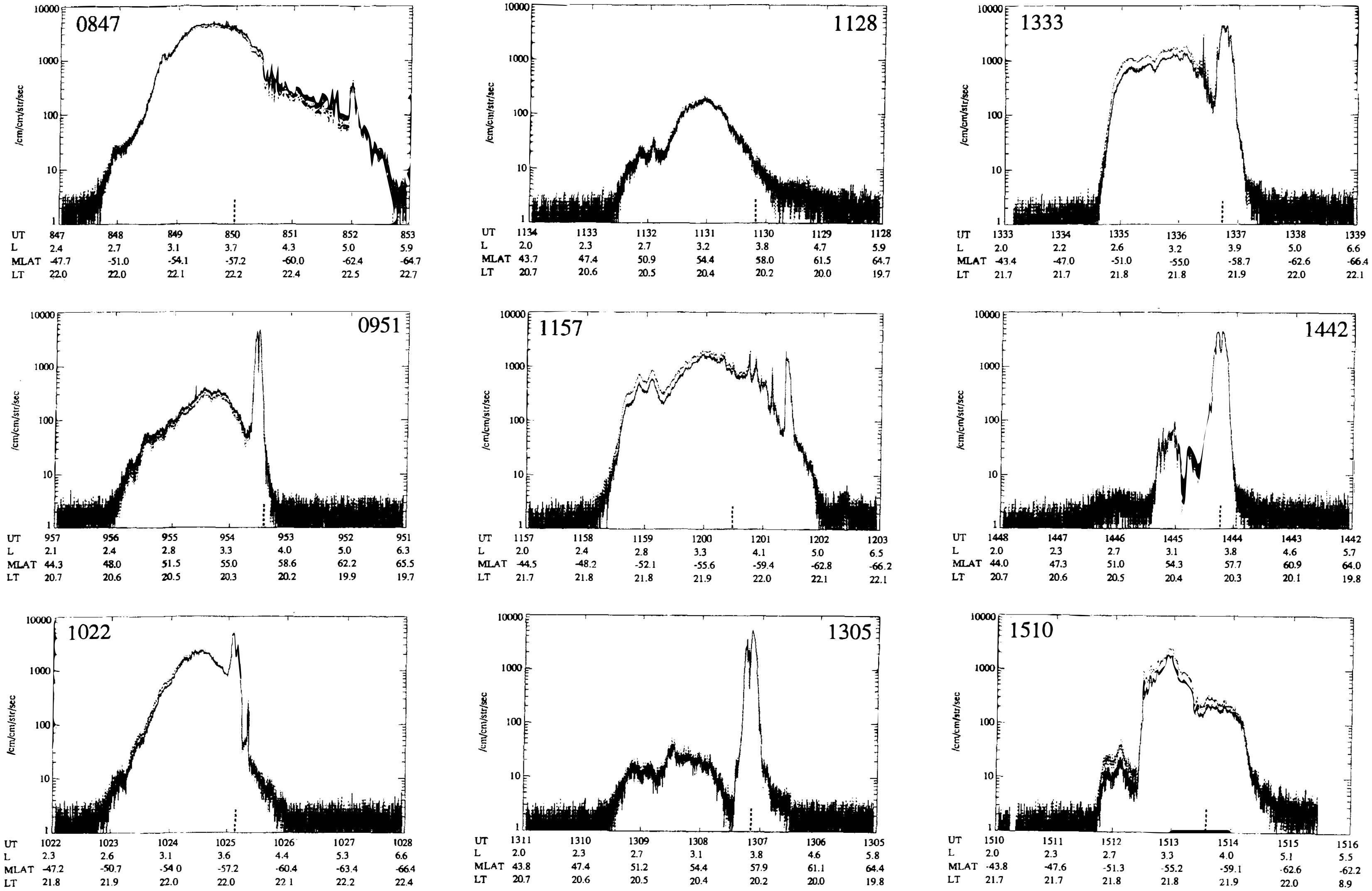
It is of great importance to study particle acceleration and loss mechanisms in order to understand the energy transfer processes in the magnetosphere. Dynamical changes of relativistic electrons in the radiation belts have been observed associated with large storm effects (GUSSENHOVEN *et al*., 1989). Precipitation, which is one of the loss processes, causes large amount of energy deposition at lower latitudes, playing a key role in magnetosphere-ionosphere or magnetosphere-atmosphere coupling. This study reports on characteristic precipitation of relativistic electron observed near the outer edge of the outer radiation belt. We analyze high-resolution (0.1 s) data obtained by the Heavy Ion Large Telescope (HILT) experiment onboard the Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX) satellite.

The SAMPEX satellite, launched on July 3, 1992, has an orbit altitude of 520×670 km and an inclination of 81.7°. The local time of the satellite repeats with a period of about 80 days. The overall configuration of the SAMPEX spacecraft is given by BAKER *et al*. (1993). The HILT sensor on SAMPEX is designed to measure heavy ions (helium to iron) in the energy range 4-250 MeV/nucleon. The HILT solid state detectors (SSD) are also sensitive to electrons so that the singles count rates are dominated by >1 MeV electrons during passes of the outer radiation belts (KLECKER *et al*., 1993). The detectors are looking toward the zenith, with each row of four detectors connected to one amplifier chain. In this study, high resolution data (~0.1 s) measured by the four rows of detectors are used. The four rows of sensors each have a geometric factor of ~25 cm^2 str and a view angle of 68°×68°. Full description of the HILT system is given by KLECKER *et al*. (1993).

Figure 1 shows the electron flux from the SSD1 (solid line) and SSD4 (dotted line) sensors during 9 consecutive radiation belt crossings in the pre-midnight sector on day 254, 1993. The earliest orbit is plotted in the upper left-handside panel. The following orbits are plotted in the same manner, from top to bottom and from the left to the right. Each plot starts at the lowest latitude. The earliest UT is marked at the top and the location of $L=3.7$ is marked at the bottom of each panel. In the following we discuss about two

92 Day 254 HILT (—— SSD1, ... SSD4)



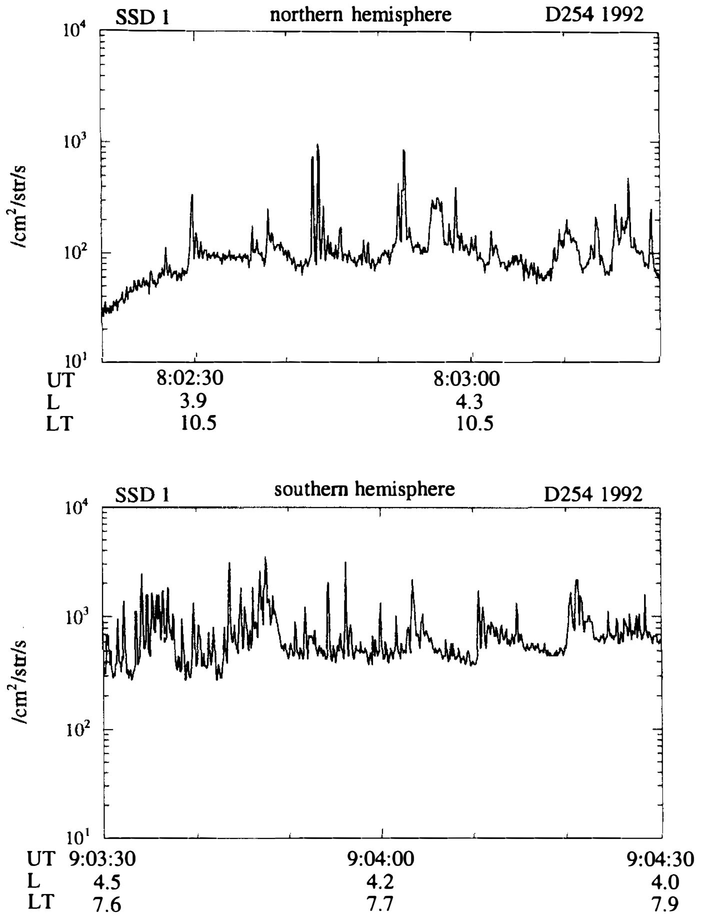


Fig. 2. *Two examples of the microbursts of energetic electron (> 1 MeV) which occurred during two consecutive orbits on Day 254, 1992 (from* Nakamura *et al., 1995). Many microburst trails show a sharp increase in flux followed by fluctuations with a more slowly decaying amplitide such as the ones at 0802:28, 0802:36, 0803:16, 0904: 03, 0904:09, and 0904:18 UT. This behavior was observed in both orbits, when the satellite traversed from the pole to the equator and vice versa.*

Fig. 1(opposite). The electron flux from the HILT solid state detectors (SSD), SSD1 and SSD4, during 9 consecutive crossings of the outer radiation belt in the pre-midnight sector (from Nakamura *et al., 1995). The earliest UT shown in each panel is marked at the top. The dashed line at the bottom shows the location of L = 3.7. During crossings, such as the 0951, 1022, 1305, 1333, and 1442 UT crossings, bands of precipitation with a time scale of 10–30 s were prominent near the high latitude edge of the precipitation region. These narrow, persistent, latitudinal bands of precipitation develop and decay with a time scale of a few hours. Acceleration processes more effective than the usual radial diffusion process or scattering process would be needed to explain this strong precipitation band phenomenon. Another prominent signature is microbursts with a time scale down to a few hundred milliseconds, such as those in the 1157 and 1333 UT crossings. Observed characteristics of these microbursts suggest that these bursts are due to wave-particle interaction involving a relaxation-oscillator type of mechanism.*

types of precipitation pattern we have observed during many of the radiation belt crossings.

1) Precipitation bands

Enhanced fluctuations can be identified mainly at the high latitude portion of the outer radiation belt. During several crossings, such as the 0951, 1022, 1305, 1333, and 1442 UT crossings, bands of precipitation with a time scale of 10–30 s were prominent near the high latitude edge of the precipitation region. The flux level of the bands often exceeds that of the main part of the radiation belt. We will call this precipitation near the high latitude edge of the outer radiation belt as "precipitation bands". The dotted lines and the solid lines coincide during these precipitation bands, while the two traces slightly differ in the inner L region. The SSD1 and SSD4 view different local pitch-angles through the HILT aperture. Accordingly, the precipitation bands correspond to an isotropic electron population, while the precipitation at lower L region corresponds to an unfilled loss cone.

The precipitation bands recurrently appear in the region $L=3.7$ in both hemispheres with a time scale of a few hours, such as in the 0951–1022 and 1305–1442 UT crossings. Effective acceleration more than the usual radial diffusion process or scattering processes would be needed to explain the observed temporal scale. Such a process would likely involve the whole flux tube since these bands are observed also in the conjugate hemisphere.

2) Precipitation bursts

Another precipitation type prominent in the SAMPEX data is the shorter time scale bursts down to a few hundred milliseconds, such as those in the 1157 and 1333 UT crossings in Fig. 1. These microbursts are usually distributed in the high latitude portion of the outer radiation belt. Figure 2 shows two examples of the microbursts of energetic electron ($1>$MeV) which occurred during two consecutive orbits on Day 254, 1992 (from NAKAMURA *et al*., 1995). Many microburst trails show a sharp increase in flux followed by fluctuations with a more slowly decaying amplitude such as the ones at 0802:28, 0802:36, 0803:16, 0904:03, 0904:09, and 0904:18 UT. Unlike the precipitation bands, microbursts die out during the interval between the next orbit. The similar profile observed at both hemisphere suggests that this feature is due to a temporal evolution of the microbursts rather than a spatial structure. By performing FFT analysis we have obtained that the frequency of the burst is about the time-scale of the bounce time of an electron ($\sim$0.3 s). Relaxation oscillator mechanism such as proposed for pulsating auroral cases would explain this kind of fluctuations.

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