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Rapid changes in electron pitch angle distributions

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Wave-particle interactions in the radiation belts are known to cause dramatic changes in the pitch angle distributions of electrons in the outer radiation belt. Pitch angle distribution evolutions can be a useful way to understand the energization and loss of these electrons. It has been proposed that electrons may be energized coherently across energies, pitch angles, L-shell, and altitudes [1]. Studies have also suggested that pitch angles near 90°, may be energized preferentially during geomagnetic storm times [2]. Pancake distributions, in particular, may be caused by inward radial diffusion or wave-particle interactions during storm times. However, these changes may also occur during quieter times. We have previously reported on the long-term evolution of relativistic and ultrarelativistic energies during storm times, finding that electron pitch angle distributions in this regime become anisotropic in the day after dst minimum, and slowly isotropize to their prestorm values in the following week. Using data from the Van Allen Probes, we analyze more rapid changes in the electron pitch angle distributions during storm and pre-storm periods. The REPT and MasEIS instruments cover a wide energy range, 10s of keV to ~10MeV, and the spinning twin spacecraft allow for the pitch angle distribution resolution needed to analyze rapid changes. We fit pitch angle distributions with the functional form $J_0 \sin^n\theta$, assigning a pitch angle index, n, to the distributions. Tracking the pitch angle index, n, over orbits and energies, we observe rapid and significant changes in pitch angle distributions over tens of electron drift periods during nonstorm times. We find that even moderate changes in geomagnetic activity can produce sharp pitch angle distribution changes in relativistic and ultrarelativistic electrons, while the relatively lower energy electron distributions remain unchanged.

References

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