Project Details

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Selection Year: 2008
Program Element: Focused Science Topic

Topic: Focused science topics for Strategic Goal 3 (Near Earth Radiation): Toward combined models of acceleration, loss and transport of energetic electrons and protons in the magnetosphere

Project Title:
An Investigation of the Electron Outer Radiation Belt's Boundaries

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Summary:
The population of relativistic electrons (E>0.511MeV) in the Earth's outer radiation belt creates a hazardous environment for space missions. As stated by the Focused science topics for Strategic Goal 3, a combined model of relativistic electrons requires "a global understanding of the influence of" critical physics processes controlling relativistic electron dynamics, and "this includes the transition region in the near Earth (6-12Re)". Here we propose to investigate the electron loss by precipitation through the low-altitude boundary and the loss by magnetopause shadowing through the high-altitude boundary, aiming to determine the relative roles of these permanent loss mechanisms in controlling the dynamics of the outer radiation belt. We also propose to specify the conditions in the transition region and to establish their connection to the trapped relativistic electron population.

This research work involves comparison of simultaneous observations from multi-points. First, based on low-altitude observations (SAMPEX and POES), we will develop a statistical model of precipitation as functions of electron energy, longitude, latitude/L-shell, local time, seasons, storm phases and solar-cycle phases. This model, especially the local time distribution and energy dependence, will reveal dominant wave-particle interaction(s) causing precipitation into the atmosphere. In addition, by comparing the decay rate of trapped electrons observed near the magnetic equator (LANL GEO, GPS and Polar) to precipitation fluxes in the loss cone, we can quantitatively determine the role of precipitation on the loss of relativistic electrons for the radiation belt with L>4. Second, the loss of electrons by magnetopause shadowing/outward diffusion will be evaluated by comparing equatorial observations at different L-shells (GPS, LANL GEO and SCATHA). Finally, we will obtain the specification of the transition region by observations crossing this area (Polar and SCATHA), and then study the effects of this region on variations of trapped energetic electrons during disturbed times (GPS, LANL GEO, Polar and SCATHA).

This work addresses the following specific scientific questions:

1. At the low-altitude boundary: Is the precipitation distribution of relativistic electrons, especially the local time and energy dependences, consistent with observed wave distributions? What are the roles of pitch-angle scattering mechanisms, and how do they evolve with geomagnetic and magnetospheric conditions?

2. At the high-altitude boundary: Can and when does magnetopause shadowing/outward diffusion dominate over precipitation in the loss of relativistic electrons?

3. In the transition region: What is the electron radial profile across the boundary? Can we demonstrate the connection between the "seed" electron population in this region and the enhancement of trapped relativistic electrons?

Understanding and specifying loss through boundaries and the transition region in the radiation belts clearly fits NASA s strategic goal 3B and research objectives that are to "understand the fundamental physical processes of the space environment..." and "develop the capability to predict the extreme and dynamic conditions in space..." due to the adverse effects of energetic electrons on satellites and humans in near-Earth space.

Publication References:

no references