Project Details

ROSES ID: NNH20ZDA001N
Selection Year: 2020
Program Element: Focused Science Topic

Topic: Understanding and Predicting Radiation Belt Loss in the Coupled Magnetosphere

Project Title:
The Contribution of Atmospheric Precipitation to Radiation Belt Loss: When, Where, and How

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Summary:
While NASA's Van Allen Probes mission has greatly enhanced our understanding of electron acceleration mechanisms in Earth s radiation belts over the past decade, quantitative physics-based understanding of loss mechanisms remains elusive. In particular, improved understanding of the timing, location, and drivers of energetic electron precipitation into Earth s atmosphere is needed. Losses to the magnetopause often cannot fully account for depletions observed across the outer radiation belt during dropout events and while diffusion models can now reproduce observed acceleration events quite accurately, radiation belt depletions are less well-captured. A more complete picture of global precipitation rates and drivers is an essential step towards understanding radiation belt dynamics and ultimately predicting relativistic electron variations.

This proposal aims to address the following questions:
1. When and where does MeV electron precipitation into Earth s atmosphere occur?
2. How much loss does precipitation contribute during dropout events as compared to other times?
3. What drives MeV electron precipitation and how does this vary across L shell, magnetic local time (MLT), and storm phase?

To address the questions above, we propose to examine the temporal profiles and global distributions of energetic electron precipitation in relation to trapped radiation belt evolution. To do this we will utilize observations of both precipitation from low Earth orbit (LEO) (utilizing the currently operating CALorimetric Electron Telescope (CALET) instrument onboard the International Space Station (ISS), as well as the historical ~20 year database from the SAMPEX satellite) in addition to equatorial measurements of the trapped electron population and fields and waves (from the Van Allen Probes and THEMIS spacecraft). The simultaneous precipitation observations from low altitude complement equatorial measurements of trapped particles and wave distributions to provide a more complete picture of trapped and precipitating electrons variations, wave drivers, and magnetospheric dynamics. Using these data, we plan to perform the following specific tasks:

1. Identify and characterize precipitation features in CALET and SAMPEX - classify by precipitation type/time profile, spectral hardness, and location (MLT, L)
2. Perform superposed epoch studies of precipitation during radiation belt dropouts and quantify the relative losses across different storm phases and locations (MLT, L)
3. Investigate the wave drivers of different precipitation types through magnetically conjugate observations from CALET and RBSP (2015-2019) and SAMPEX and THEMIS (2007-2012)

Through these coordinated studies, this work will determine the contribution of precipitation to overall radiation belt dynamics and loss, and identify when and where various precipitation drivers are occurring. These aims are directly relevant to the Focus Science Topic Understanding and predicting radiation belt loss in the coupled magnetosphere and can inform radiation belt modeling efforts to more accurately capture energetic electron precipitation loss.

Publication References:

no references