Project Details

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Program Element: Focused Science Topic

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

Project Title:
Quantifying the Global Precipitation of Energetic Electrons and Its Relative Contribution to Radiation Belt Dropout

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Summary:
Energetic electron flux in the Earth s radiation belt are observed to drop by orders of magnitude on timescales of a few hours. Where do the electrons go? Radiation belt electrons can be lost either by transport across the magnetopause into interplanetary space or by precipitation into the atmosphere. Therefore, quantifying the precipitation loss of energetic electrons and its relative contribution to fast radiation belt dropout is one of the most compelling science objectives in radiation belt studies. However, the global picture of precipitation has not been quantified at high spatial and temporal resolution due to the lack of physical models that directly simulate the precipitating electrons observed at low altitude. Furthermore, the relative importance of precipitation to radiation belt dropout is not yet understood due to the lack of models that link low-altitude precipitation with high-altitude electron dropout.

Here, we propose to use the newly developed Drift-Diffusion model, which includes the effects of pitch angle diffusion, azimuthal drift, and atmospheric backscatter, to simulate the distributions of drift-loss-cone (DLC) and bounce-loss-cone (BLC) electrons observed by multiple NOAA/POES satellites at low altitude during selected dropout events. The model will quantify electron precipitation over all longitudes with high temporal and spatial resolution. Physical forms of pitch angle diffusion coefficients derived from quasi-linear theory of wave-particle interactions will be used in the model to resolve the waves that are responsible for pitch angle diffusion and the magnetic local time and L distribution of the waves. The derived wave intensity will be further compared with wave data from Van Allen Probes to seek direct evidence of wave-particle interactions. Additionally, since the DLC and BLC electrons at low altitude show distinct longitude distribution at different levels of pitch angle diffusion, we will develop a new proxy model for precipitation based on easily calculated characteristic indices of the count rate vs. longitude distribution observed by POES satellites. The proxy model will be validated against detailed event simulations and serve as an efficient method to quantify the precipitation of radiation belt electrons. Finally, the predicted electron loss at high altitude due to precipitation from our model will be compared with the observed electron dropout by Van Allen Probes to quantify the relative contribution of precipitation to the overall loss. This will be done both in event studies using the Drift-Diffusion model and statistically using the proxy model, to resolve the relative importance of precipitation to radiation belt dropout at various electron energies, locations, and geomagnetic conditions.

To sum, we will address the following compelling science objectives:

" Quantify the global picture of energetic electron precipitation with high temporal and spatial resolution and resolve the wave-particle interaction processes that are responsible for the observed precipitation;

" Develop a new proxy model for precipitation based on the longitude distribution of electron count rates observed at low altitude;

" Resolve the relative contribution of precipitation to observed radiation belt dropout at various electron energies, locations, and geomagnetic conditions.

These objectives are highly relevant to the 2nd science objective of the FST that is Improved understanding and ability to predict the radiation loss processes are impacted by non-adiabatic dropout event . The proposed work also directly addresses two types of investigations targeted by the FST, which are Quantifying the relative roles played by precipitation into the atmosphere versus non-adiabatic loss processes and Modeling non-adiabatic radiation belt drop-out events to understand the underlying physical processes .

Publication References:

no references