Project Details

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Program Element: Focused Science Topic

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

Project Title:
Investigating the contribution of microbursts to radiation belt losses

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Summary:
Chorus waves have been suspected for some time now to be the dominant cause of relativistic microbursts, which represent an important source of electron loss from the outer radiation belt. Due to a prior scarcity of temporally- and spatially-connected observations of the waves causing the scattering (in the magnetosphere) and the resulting precipitation (observable at low Earth orbit), details of the scattering process are largely unknown. To address this scarcity, in recent years the FIREBIRD CubeSat and Van Allen Probes Electric Fields and Waves teams have worked closely to produce a novel conjunction dataset that now consists of more than 150 days of conjunctions with >100 hours of simultaneous high time resolution burst waveform and high time and energy resolution electron flux measurements. This combined dataset is the first of its kind that will allow a strongly constrained intercomparison of the microburst creation process. Because the scattering likely occurs away from the chorus observations, available conjunction observations alone are unable to fully characterize this scattering process. We will fill this observational gap by applying our recently developed sophisticated chorus wave model and test particle simulation tool to the conjunction dataset. Specifically, we will achieve the following objectives:

O1. Characterization of the observed microbursts and their association with chorus wave properties.
O2. Investigation of the dependence of microbursts on the properties of chorus waves and the properties of ambient thermal and suprathermal plasmas.
O3. Assessment of how well the chorus waves can account for the microbursts during conjugation events.
O4. Parameterization of electron precipitation loss due to chorus waves.

For O1, we will go through the established dataset of FIREBIRD/Van Allen Probes conjunctions to identify the events containing chorus waves and without other potential waves around, and to determine microburst and chorus wave properties for these events. We will sort peak flux and duration as a function of energy. The obtained chorus wave properties and microburst properties will be compared to see any observable dependence.

For O2, we will use the established ray-tracing chorus model and test particle simulation to examine the dependence of microburst creation. We will simulate electron precipitation as a function of energy and time by varying chorus wave parameters and by varying chorus source location and plasma density. We will investigate the effect of these parameters by varying each parameter while holding the others fixed.

For O3, we will select a few of the closest conjunctions of chorus/microbursts to run event-specific modeling. For each event, we will extract the observed chorus properties from Van Allen Probes data and microburst precipitation from FIREBIRD data. Observed chorus properties will be input to our ray-tracing simulation to constrain model chorus sources. The obtained precipitation flux from the test particle simulation in the modeled chorus waves will be compared directly against FIREBIRD data.

For O4, we will obtain chorus wave statistic properties parameterized by Kp, L, and MLT, and perform test particle simulation to simulate microbursts for statistic properties of chorus waves. We will build and publish a parameterization of precipitation loss time scale due to chorus waves as a function of L, MLT and Kp, and work with FST team to implement this effect.

This research is relevant to the overall objective of Van Allen Probes mission, Goal #2 of the Heliospheric Decadal Survey, and Objective H2 of the 2009-2030 Heliophysics roadmap. This proposed research of discovering electron losses due to microbursts directly contributes to FST #2 Understanding and Predicting Radiation Belt Loss in the Coupled Magnetosphere .

Publication References:

no references