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:
Developing the scientific understanding and prediction capability of enhanced radiation levels at aviation altitudes due to energetic electron precipitation

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Summary:
The goal of our proposed project is to develop a comprehensive scientific understanding and a prediction capability of recently discovered enhanced radiation level events that were observed in measurements taken on commercial altitude (above 9 km) aircraft. These events are thought to result from the precipitation of >2 MeV electrons, which drive gamma-ray beams due to Bremsstrahlung. The measurements are made using the operational Automated Radiation Measurements for Aerospace Safety (ARMAS) system flown on agency-sponsored flights (NASA, NOAA, NSF, FAA, DOE) in automated radiation collection mode, as well by commercial space transportation companies and airliners. By late 2019, ARMAS obtained real-time radiation measurements from the ground to 89 km altitude for >700 flights consisting of >200,000 science quality one-minute measured absorbed dose (silicon) and derived effective dose rate records.

For decades, galactic cosmic rays (GCRs) and solar energetic particles (SEPs) were believed to be the two major sources of atmospheric radiation occurring at aviation altitudes. However, a case study using a subset of ARMAS data revealed a dynamic and variable radiation environment, occurring in a narrow magnetic latitude band (corresponding to L-shells of 2 2 MeV electrons on Van Allen Probes suggest that 5 "-ray beams may be produced at mesospheric altitudes by precipitating relativistic electrons from the radiation belts, likely precipitated by electromagnetic ion cyclotron (EMIC) waves.

In response to Focused Science Topic 2 Understanding and Predicting Radiation Belt Loss in the Coupled Magnetosphere , which addresses Decadal Survey Key Science Goal 2 (Determine the dynamics and coupling of Earth s magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs), and several LWS Strategic Science Areas including SSA-IV (Variability of the Geomagnetic Environment) and SSA-VIII (Radiation and Particle Environment from Near Earth to Deep Space), we propose a 4-year project whose main goals and objectives are:

1. Understand the spatial and temporal distribution, and variability of Aviation Altitude Radiation Events (AAREs), and their correlation to geomagnetic conditions
2. Understand the relationship of AAREs to the waves observed simultaneously near the geomagnetic equator through coincident observations and physics-based diffusion modeling
3. Predict the occurrence of AAREs using machine learning techniques based on their relationship to geomagnetic driving and coincident wave observations
4. Quantify the total loss of energetic electrons that results in AARE s and compare to radiation belt dropout events to determine their fraction of total electron loss

The methodology we will employ involves a statistical examination of the ARMAS database, comparison to Van Allen Probes wave observations, both for conjunction events, and in a global statistical sense, diffusion-based modeling of radiation belt precipitation, and machine-learning based prediction of the occurrence location, time, and magnitude of AARE events.

This proposal is highly timely due to the availability of the ARMAS database, and contributes to the FST effort by providing real measurements at aviation altitudes of the end result of energetic electron precipitation, which exemplifies the LWS overall purpose of & to understand those aspects of the Sun and Earth's space environment that affect life and society .

Publication References:

no references