Project Details

ROSES ID: NNH16ZDA001N
Selection Year: 2016
Program Element: Focused Science Topic

Topic: Characterization of the Earth's Radiation Environment

Project Title:
Characterizing the Earth's Radiation Environment: A Flux Model of the Inner Magnetosphere.

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Summary:
The goal of the project is to advance a currently existing model of the electron and ion fluxes in the inner magnetosphere by extending the spatial coverage to L~2-7, and extending the energy coverage to ~0.001-2000 keV. The project will build on the framework and methodology of a freely-available and independently-tested model that currently delivers forecasts of the ion and electron fluxes at geosynchronous orbit (GEO) [Denton et al., 2015; Denton et al., 2016]. Since its development the model has been successfully utilized by a variety of groups in the community with a science, operations, and commercial focus.

The methodology is based on statistical analyses of large spacecraft datasets, primarily from the Van Allen Probes mission, supplemented by data from the GOES and LANL satellite clusters. Following on-orbit intercalibration, the data will be coupled into the existing model, which is currently driven by either the Kp index or the solar-wind electric field (-vswBz). The latter allows flux forecasts with a ~1 hour lead-time. Predictions at GEO are in good agreement with independent observations. To produce model outputs that provide a robust and accurate predictive capability throughout the entire inner magnetosphere we will extend the current model by ingesting the new data to permit spatial predictions inwards from GEO and also elevate the maximum energy of model from ~40 keV to ~2 MeV. All available data will be assigned to spatial bins in L (and/or L*) and local-time, at discrete values of Kp and -vswBz, and energy. Tri/quad-linear interpolation will be used to produce model flux values for any chosen input parameters. The final product will be made freely available to the community and will permit the mean flux, median, standard deviation, and percentiles all to be output at an arbitrary time cadence for all possible energies. It is envisaged that two different models will evolve (one for GEO and one for the magnetosphere inwards of GEO).

The objectives are:

1. Statistically determine the variation of the ion and electron fluxes as a function of Kp, and as a function-vswBz, using the extensive database of Van Allen Probes, GOES, and LANL observations.

2. Test/quantify model predictions from Objective 1 with in-situ data using normalized RMSD and Heidke Skill Score metrics.

3. Generate a total-dose-prediction capability for satellites of arbitrary orbit within the inner magnetosphere based on historical input data over the satellite lifetime.

The compelling nature of this proposal lies in the ability of the current model to produce reliable flux forecasts at GEO, and hence the likely successful completion of the objectives outlined above. Improving the error estimates will form a large part of the effort in the work effort of the project.

The timeliness of the proposal arises from the maturity of the three satellite constellations with each having substantial datasets for robust statistical analysis.

The feasibility of the work is demonstrated by the fact that the model has already produced independently tested flux forecasts at GEO. The data required for the work have already been taken - the proposal is inherently low risk. Also, the proposal team has a proven track-record of developing data-analysis and modeling techniques for large-data sets and for case-study analysis of individual events.

PROPOSED CONTRIBUTIONS TO THE FOCUS TEAM EFFORT: The PI is keen to serve as Team Leader for the Focus Team Effort. He will ensure that the individual teams collaborate to avoid unnecessary duplication of effort. Also he will aim to introduce common metrics for analyzing uncertainties between the different groups to aid comparisons.

The proposal is relevant to Key Science Goal 2 from the National Research Council Decadal Survey on Heliophysics: Determine the dynamics and coupling of Earth s magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs.

Publication References:

no references