# Project Details

**ROSES ID:** NNH18ZDA001N
**Selection Year:** 2018
**Program Element:** Focused Science Topic

**Topic:** Understanding the Response of Magnetospheric Plasma Populations to Solar Wind Structures

**Project Title:**
The Response of Inner Magnetosphere Wave-Particle Interaction Regime and Efficiency to Solar Wind Parameters

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**Summary:**
The Earth's radiation belts present a natural space hazard to space exploration. Energetic particles cause single-event upsets and deep dielectric charging in spacecraft electronics and may be harmful to humans in space. Although the past several years have seen a great progress in understanding the processes that drive radiation belt dynamics, and much data has been collected by missions such as the Van Allen Probes empirical models are still the best approach to the modeling of the electron flux dynamics.
We propose a new model of energetic electron diffusion rates based on the VLF measurements in the radiation belts by the NASA missions DE1, CRRES, Polar, Cluster, THEMIS, and Van Allen Probes covering three solar cycles (from 1981 to 2018 with a gap in 1990s) and the most comprehensive approach to calculation of the diffusion coefficients (taking into account wave normal angle distribution, wave intensity at off-equatorial regions, and the local plasma density) to evaluate how the dynamics of solar wind affect the transport, acceleration and loss mechanisms of the inner magnetosphere radiation environment. Also, we will develop the patch of the model extending its applicability to the extremely perturbed parameters of solar wind through the special processing of the highest observed geomagnetic storms (DE1 and Cluster measurements) as well as the most powerful storms from the Van Allen Probe mission (with Cluster and THEMIS data)
Science Objectives:
1. Development of the empirical model of the VLF activity in the inner magnetosphere on the solar wind parameters;
2. Calculating and parametrization the wave-particle interaction efficiency under the quasi-linear approximation;
3. Extending the model to the highest observed solar wind parameters;
4. Validation of the model on the available spacecraft VLF data in the statistical pattern, on the intense geomagnetic storm case studies, and investigation of scaling possibility to the extreme geomagnetic events.
Methodology is based on the multi missions VLF spectral matrices and waveform analysis (amplitude distribution, wave normal distribution); the wave parameters database development (including the location and solar wind parameters); statistical processing of the database (to determine the key correlations); numerical calculations of the scattering and acceleration rated under the quasilinear approximation; statistical analysis of the model remains for validation of the model (case studies and statistical processing with the spacecraft data comparison).
Relevance to the LWS FST: The proposed study will evaluate the response of the efficiency of wave-particle interaction in the inner magnetosphere to the solar wind parameters providing the empirical model for the wave-particle scattering and acceleration rates, validation of the model (evaluating the applicability limitations) with the available spacecraft data, thus, will contribute to the FST topic  Understanding the Response of Magnetospheric Plasma Populations to Solar Wind Structures .
The expected impacts would be to LWS-TRT Strategic Science Areas SSA-0 SSA-1 and SSA-6.
The proposed model, based on the all available VLF spacecraft measurements (covering 3 solar cycles) and taking into account the recent findings in wave-particle interactions physics will be a necessary component for the models of the magnetosphere dynamics and a valuable part of the Focused Science Team effort. The global models of the magnetosphere dynamics driven by the solar wind include wave-particle interactions as a significant part responsible for seed (50-100 keV) and core (subrelativistic and relativistic) electron populations in the inner magnetosphere. The existing wave models are too simplified (the output is wave amplitude without latitude dependence, wave normal angle distribution, plasma density model) and limited by weakly perturbed conditions (Kp