# Project Details

**ROSES ID:** NNH13ZDA001N
**Selection Year:** 2013
**Program Element:** Focused Science Topic

**Topic:** Connection between Solar Interplanetary Structures and the response of Earth's radiation belts

**Project Title:**
Relative Roles of Different Solar Wind Drivers of ULF Waves in Radial Transport of Relativistic Electrons in the Outer Radiation Belt

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**Summary:**
Relativistic electron intensities across the outer radiation belt vary on the timescales from minutes to days. A major mechanism responsible for this variability is radial transport of electrons across their drift shells. Radial transport is driven by interactions of the gradient-curvature longitudinal drift motion of trapped particles around Earth with the ULF waves in the Pc4-5 frequency range (2-22 mHz). The waves with small azimuthal wave number (m) can resonantly interact with the electron drift motion leading to effective scattering of particles across the drift shells. The dominant low-m ULF modes draw their energy from different sources of solar wind origin. First, ULF waves can be generated by the Kelvin-Helmholtz instability (KHI) at the magnetopause flanks. Another major source of ULF wave activity is fluctuations in the solar wind dynamic pressure. Magnetosonic waves induced at the magnetopause couple with standing Alfven waves termed field line resonances. Magnetosonic waves can also get trapped inside and reflected from the plasmapause resulting in global cavity modes. While previous studies established that low-m ULF waves can resonantly interact with the electron drift motion, the relative importance of the waves of different solar wind origin in sculpting radial profiles of radiation belt intensities still remains a mystery. The proposed study is intended to close this understanding gap via addressing fundamental science questions of ULF wave interaction with relativistic electrons in the outer radiation belt:

1) What are the properties and rates of radial transport driven by the two main types of the solar-wind driven ULF waves: velocity shear induced KHI and dynamic pressure variations?

2) What is the difference in transport due to a single isolated ULF mechanism compared to realistic conditions when both ULF wave mechanisms operate simultaneously?

3) What is the relative contribution of radial transport due to externally driven ULF waves in the build up and decay of radiation belt intensities during events observed by the Van Allen Probes?

We will use a global MHD model of magnetospheric dynamics (LFM), and a 3D guiding center radiation belt model. The global model possesses both very high resolution and the ability to simulate the cold plasmasphere, which are necessary to reproduce the KHI and properly describe mode coupling. The fully 3D test-particle model is necessary to 1) describe possible deviations of the transport from radial diffusion, requiring kinetic rather than phase-averaged (Fokker-Planck) approximation; 2) take into account 3D aspects of particle motion, e.g., drift orbit splitting and orbit bifurcations. Our science investigation will be based on a series of numerical experiments: First, with idealized solar wind and IMF conditions allowing separation of KHI and dynamic pressure driven modes; Second, with realistic solar wind inputs allowing direct assessment of electron radial transport with observations by Van Allen Probes. Relative contributions of the different ULF generation mechanisms will be assessed by computing transport rates from the 3D test-particle simulations in the resultant MHD fields.

Proposed Contribution to the Focus Team Effort: The proposed research is directly relevant to Focused Science Topic (c), the Connection between Solar Interplanetary Structures and the response of Earth s radiation belts . The research will contribute to the focus team efforts both by providing global models to aid in analysis of observational studies and characterizing the physical processes responsible for radial transport of electrons in the outer belt. The project metrics will assess progress in (1) completion of simulations of idealized cases and event studies and (2) in understanding the relative roles of different ULF generation mechanisms in radial transport of relativistic electrons.

## Publication References:

no references