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:
Effect of Alfve?n Fluctuations in Solar Wind on Dynamic Variability of Outer Delt Relativistic Electrons

PI Name: Heejeong Kim
PI Email: heekim@atmos.ucla.edu
Affiliation: University of California, Los Angeles
Summary:
Although IMF Bz primarily controls the amount of solar wind energy input, it has been observed that Alfve n fluctuations in solar wind structure can be an important contributor to the large-scale transfer of solar wind energy. Our recent analysis of incoherent scatter radars and THEMIS satellites data showed evidence that enhanced Alfve n waves in solar wind can substantially affect the global convection and contribute to plasma sheet structure and dynamics, and to the occurrence of disturbances such as substorms, even under northward IMF. In particular, our recent observations suggest that there may be a close connection between solar wind fluctuations, localized flow structures within the polar cap, and geomagnetic disturbances, which provides important clues on how solar wind energy can be coupled and transmitted to the magnetosphere-ionosphere system associated with enhanced Alfven fluctuations in solar wind.

It is known that large-amplitude north-south Alfve n fluctuations in IMF within the high- speed streams are associated with large enhancements in relativistic electron flux in the outer radiation belt, so-called relativistic electron events. In our early studies, we found that these waves can last for multiple days and cause intermittent occurrences of significantly enhanced magnetospheric convection. The enhanced convection periods are followed by repetitive substorm onsets. Repetitive injections of 10s to 100s keV electrons to the inner magnetosphere during substorm dipolarizations can provide the seed populations that are subsequently energized to MeV electrons. Prolonged periods of large-amplitude Alfve n waves embedded in high-speed solar wind streams can also lead to enhancement of both dawn-side chorus wave and magnetospheric ULF turbulence that are postulated to cause the relativistic electron energization. Although relativistic electron events occur during geomagnetic storms that are mostly associated with high-speed solar wind streams, some geomagnetic storms do not accompany relativistic electron events. This suggests that multiple factors in the solar wind or/and in the magnetosphere are required to work together to produce a relativistic electron event.

The primary goal of this proposal is to determine essential magnetospheric conditions for occurrence of relativistic electron events and what solar wind and interplanetary structure can drive those conditions. We will particularly focus on the role of Alfve n waves in the solar wind density and IMF; how their Alfve n wave power are correlated with outer belt MeV electron intensities after removal of all other solar wind and IMF effects, whether there exist certain cutoff values of wave power, time lag, and duration of Alfve n fluctuations for a relativistic electron event to take place, how Alfve n waves affect the plasmasheet conditions for providing the seed population and magnetospheric wave activity, and whether the enhanced and structured polar-cap convection driven by the interplanetary Alfve n fluctuations can be an important part of the process leading to the relativistic electron events. To do this, we will statistically analyze OMNI data for solar wind structures and Alfve n wave power, GEOTAIL and THEMIS data for the plasmasheet and the inner magnetosphere, AE index for substorm occurrence, ground magnetometer data for wave activities, radar observations for polar cap flows, and GOES and Akebono data for radiation belt electron fluxes.

The proposed work will evaluate effect of Alfve n fluctuations in solar wind on outer belt relativistic electron intensities by examining magnetospheric conditions from the polar cap, to the plasmasheet, and to the radiation belts associated with Alfve n waves in solar wind. Therefore this study will directly address the goal of LWS focused science topic Connection between Solar Interplanetary Structures and the response of Earths radiation belts".

Publication References:

Summary: no summary

Reference: Kim, Hee-Jeong; Lyons, Larry; Pinto, Victor; Wang, Chih-Ping; Kim, Kyung-Chan; (2015), Revisit of relationship between geosynchronous relativistic electron enhancements and magnetic storms, Geophysical Research Letters, Volume 42, Issue 15, pp. 6155-6161, doi: 10.1002/2015GL065192