Contribution ID: **4** Type: **not specified**

The Role of Solar and Solar Wind Forcing of Radiation Belt Particle Enhancements

Monday 19 October 2015 16:15 (45 minutes)

Observational and numerical modeling evidence demonstrates that solar wind streams and coronal mass ejections drive coherent processes within the coupled near-Earth system. The magnetosphere progresses through a specific sequence of energy-loading and stress-developing states until the entire system suddenly reconfigures. Related long-term studies of relativistic electron fluxes in the Earth's magnetosphere have revealed many of their temporal occurrence characteristics and their relationships to solar wind drivers. Early work showed the obvious and powerful role played by solar wind speed in producing subsequent high-energy electron enhancements. More recent work has also pointed out the key role that the north-south component of the IMF plays: In order to observe major relativistic electron enhancements, there must typically be a significant interval of southward IMF along with a period of high (VSW≥500 km/s) solar wind speed. This has led to the view that enhancements in geomagnetic activity are normally a key first step in the acceleration of radiation belt electrons to high energies. A second step is suggested to be a period of powerful low-frequency waves that is closely related to high values of VSW or higher frequency ("chorus") waves that rapidly heat and accelerate electrons. Hence, magnetospheric storms provide a "seed"population, while high-speed solar wind drives the acceleration to relativistic energies in this two-step geomagnetic activity scenario. This picture seems to apply to most storms examined whether associated with high-speed streams or with CME-related events, but not all. In this talk, we address the storm relationships as they pertain to high-energy electron acceleration and transport. We also discuss various models of electron energization that have recently been advanced. We present remarkable new results from the Van Allen Probes (Radiation Belt Storm Probes) mission that confirm and greatly extend these key ideas.

Summary

We use data from the NASA Van Allen Probes mission to study the changes in trapped radiation surrounding the Earth. We examine the dramatic acceleration, transport and loss of radiation belt properties by comparing with solar wind forcing by high speed solar wind streams and coronal mass ejections. Fascinating new aspects of radiation belt structure are presented and our latest understanding of physical mechanisms is summarized.

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Session Classification: Monday Afternoon 2