Project Details

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Project Title:
Efficiency of Energy Transfer from the Solar Wind, Storage in the Magnetosphere and Release into Earth’s Atmosphere

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Summary:
A key component of the Living With a Star (LWS) Targeted Research and Technology (TR&T) program is the quantification of the physics, dynamics and behavior of the Sun-Earth system over the 11-year solar cycle. The interaction of the solar wind with Earth s magnetosphere can result in the storage of large amounts of energy in the magnetospheric system. The subsequent release of this energy results in the energization of particles trapped in the magnetosphere and the acceleration into Earth s atmosphere causing the aurora. In addition, the ionosphere in the auroral zone is modified by the precipitating particles causing large variations in the height integrated conductivities and the flow of currents in the region. The rate of energy storage in the magnetosphere is related to the rate of merging of magnetic flux on the dayside of Earth. It has been known for three decades that the addition of energy to the magnetospheric system is controlled by the north/south direction of the magnetic field in the solar wind impacting Earth s magnetosphere near local noon. What is not yet well understood, however, is the efficiency of this process. In particular, what fraction of the solar wind energy flux impacting the dayside magnetosphere is converted to energy stored in Earth s magnetotail? What fraction of this stored energy is eventually deposited into the auroral ionosphere? And are there solar cycle variations? The Polar spacecraft was launched near solar minimum in February 1996 and has continued operation through today in the post-solar maximum period. Global auroral image data covering this time period from the Visible Imaging System (VIS) of the Polar spacecraft will be used to determine the instantaneous open polar cap magnetic flux. The time rate of change of this magnetic flux is the net result of magnetic merging in the solar wind-magnetosphere interaction region and of reconnection in the distant magnetic tail. During periods of low auroral activity in the nightside, the nighttime reconnection rate will be small and the change in the total open magnetic flux of the polar cap will be a direct measure of the rate of merging on the dayside. The Polar/VIS observations of total open magnetic flux of the polar cap in combination with static and dynamic pressures of the solar wind can be used to estimate the energy stored in the flaring magnetotail lobes. The HF radars of the Super Dual Auroral Radar Network (SuperDARN) have been operating for the same period with additional radars becoming operational with time. SuperDARN data will be used to determine in detail the geomagnetic flux transferred into and out of the polar cap. The SuperDARN data combined with the height integrated auroral conductivities derived from the Polar/VIS auroral images will be used to derive the joule heating dissipation in the auroral ionosphere. The solar wind parameters required for this study will be taken from publicly available key parameter data sets of the ACE, Wind, IMP?8 and Geotail spacecraft. The goal of this study is to investigate the relationship between solar wind parameters, storage of energy in the magnetosphere, and the eventual release of this energy into Earth s atmosphere. The completion of this study will result in the production of a set of parameters to allow spacecraft operators with access to an upstream solar wind monitor such as ACE or Wind to make accurate short-term predictions (of the order of 1-hour) on the effects of the solar wind on the Earth magnetosphere system.

Publication References:

Summary: ''

Reference: Fox, Nicola JHU/APL - Efficiency of Energy Transfer from the Solar Wind, Storage in the Magnetosphere and Release into Earth’s Atmosphere