Project Details

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Topic: Shock acceleration of solar energetic particles by interplanetary CMEs

Project Title:
Solar wind geoeffectiveness as a function of IMF and dynamic pressure and its effect on high-latitude ionospheric energy deposition

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Summary:
The electric field and particle precipitation patterns at high

latitudes are two of the most significant considerations for

determining the ionospheric state during steady or variable solar

wind and Interplanetary Magnetic Field (IMF) conditions. It is

therefore of primary importance to fully understand what drives

the electric fields and particle precipitation at high latitudes.

It is well known that the IMF is the major contributor to

geomagnetic activity on Earth. Recent studies, however, have shown

that solar wind dynamic pressure variations cause global effects

when they encounter the terrestrial magnetosphere, strongly

affecting the magnetosphere, ionosphere, and upper atmosphere. In

particular, it has been shown that solar wind dynamic pressure

enhancements significantly increase particle precipitation and

cause global intensification of the aurora, thus significantly

increasing the deposition of energy in the Earth's upper

atmosphere. In addition, the extent of the enhanced energy

deposition is dependent on the preexisting state of the

magnetosphere, which is controlled by the IMF orientation.

Further studies have demonstrated that solar wind pressure

increases also affect the cross-polar-cap potential drop (CPCP),

and thus the coupling efficiency between the solar wind and the

Earth's magnetosphere in ways that cannot be accounted for solely by the existing solar wind electric field. It is rather the combined contribution of IMF and dynamic pressure, in ways that are yet to be determined, that controls the coupling efficiency between the solar wind and the magnetosphere. Therefore, the pressure enhancements and IMF variations affect both the solar wind geoeffectiveness and the energy input in the high-latitude ionosphere and upper atmosphere. We propose to study the relative contribution of solar wind dynamic pressure, IMF Bz, and IMF By to solar wind geoeffectiveness during steady and variable conditions, and investigate under which circumstances the correlation between solar wind geoeffectiveness and high-latitude energy deposition is the highest. For this purpose we will utilize a combination of solar wind measurements, low-altitude Defense Meteorological Satellite Program (DMSP) data, and results of the Assimilative Mapping of Ionospheric Electrodynamics (AMIE) technique.

We will focus our research on the following scientific questions:

1) What is the effect of different IMF orientations and solar wind dynamic pressure levels on the solar wind-magnetosphere coupling efficiency under steady conditions? 2) How do variations of dynamic pressure and IMF modify the CPCP and the coupling efficiency?

3) How permanent or transient are these responses for step-like changes in the solar wind, and what are the relevant timescales?

4) What is the relative contribution of dynamic pressure and IMF orientation to the CPCP and solar wind geoeffectiveness under steady or changing conditions? 5) How do IMF orientation, dynamic pressure levels, and their changes affect high-latitude energy deposition as measured by the intensity of precipitating flux or ionospheric Joule heating?

Publication References:

Summary: no summary

Reference: Boudouridis, A.; Lyons, L. R.; Zesta, E.; Ruohoniemi, J. M.; (2007), Dayside reconnection enhancement resulting from a solar wind dynamic pressure increase, Journal of Geophysical Research: Space Physics, Volume 112, Issue A6, CiteID A06201, doi: 10.1029/2006JA012141

Summary: no summary

Reference: Boudouridis, A.; Lyons, L. R.; Zesta, E.; Weygand, J. M.; Ribeiro, A. J.; Ruohoniemi, J. M.; (2011), Statistical study of the effect of solar wind dynamic pressure fronts on the dayside and nightside ionospheric convection, Journal of Geophysical Research: Space Physics, Volume 116, Issue A10, CiteID A10233, doi: 10.1029/2011JA016582