

Project Details

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Program Element: Independent Investigation

Topic: Measure the properties of the solar dynamo that affect solar irradiance and active region generation.

Project Title:

Effect of Fluctuations in the Solar Wind on the Strength of Polar-cap Convection

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Summary:

Convection within the polar caps is fundamental to the transfer of solar wind energy to the magnetosphere-ionosphere system and thus to the LWS goal of obtaining a physics-based understanding of the integral system linking the Sun to the Solar System both directly and via the heliosphere, planetary magnetospheres, and ionospheres. It has been well known for many years that the interplanetary magnetic field (IMF) is the dominant factor in controlling the strength of this convection, and more recently solar wind dynamic pressure has been found to play a very significant role as well. In addition, radar observations of convection within the dayside polar cap that we have recently examined occasionally show large oscillations with periods of ~15 minutes, the oscillation amplitude being larger than the background convection speed. Several of the examples indicate the possibility that the overall strength of polar-cap convection can be substantially enhanced during periods of large ULF pulsations over that which occurs without the pulsations, particularly for weakly southward and northward IMF. Furthermore, our preliminary analyses suggest that the large amplitude oscillations may occur primarily when there are enhanced pulsations in solar wind parameters, such as in the solar wind dynamic pressure and in the IMF By and Bz, and that these oscillations preferentially occur within high-speed solar wind streams and ICMEs. On the other hand, the direction and magnitude of IMF do not seem to matter in the occurrence and the enhancement of the convection oscillations. These preliminary results suggest that the ULF waves may, at times, be a substantial contributor to large-scale convection and suggest their possible association with solar wind and IMF conditions. We thus believe that it is potentially of fundamental importance to determine how often, and under what conditions, the contribution from ULF waves may be significant. This is the primary goal of the present proposal, and is necessary for determining when such oscillations are likely to be an important aspect of convection, and, ultimately, for determining the cause of the oscillations. We will then consider whether they can appreciably enhance the total cross-polar cap potential drop, whether they are important simultaneously in both hemispheres or is there a hemispherical/seasonal dependence, whether they also appear in the nightside polar cap with the same characteristics as on the dayside, and whether they can lead to the occurrence of substorms (including under northward IMF, as a recent set of observations suggest) and to repetitive poleward boundary intensifications (PBIs). It will be particularly interesting if we find that the pulsations can be associated with enough energy transfer to the magnetosphere to lead to the growth and expansion phase of substorms under conditions when such energy transfer would not otherwise be expected.

For this study, we will use SuperDARN coherent-scatter radar observations to evaluate the ULF waves in convection strength within the polar caps of both the northern and southern hemispheres and the Sondrestrom incoherent scatter radars in the northern hemisphere. Considerable data is available for this purpose from both of these radar systems. To examine solar wind conditions, we will use the data from interplanetary spacecraft as Weimer-mapped to just upstream of the magnetopause nose. We will also analyze ground magnetometer data to examine the wave features within the polar cap. To investigate the possible relation with substorm and PBI occurrence, we will use standard auroral, ground magnetic, and geosynchronous energetic particle signatures.

Publication References:

Summary: no summary

Reference: Kim, H.-J.; Lyons, L. R.; Zou, S.; Boudouridis, A.; Lee, D.-Y.; Heinselman, C.; McCready, M.; (2009), Evidence that solar wind fluctuations substantially affect the strength of dayside ionospheric convection, Journal of Geophysical

Summary: no summary

Reference:

Lyons, L. R.; Kim, H.-J.; Xing, X.; Zou, S.; Lee, D.-Y.; Heinselman, C.; Nicolls, M. J.; Angelopoulos, V.; Larson, D.; McFadden, J. ; Runov, A.; Fornacon, K.-H.; (2009), Evidence that solar wind fluctuations substantially affect global convection and substorm occurrence, Journal of Geophysical Research, Volume 114, Issue A11, CitelD A11306, doi: 10.1029/2009JA014281

Summary: no summary

Reference: Kim, H.-J.; Lyons, L.; Boudouridis, A.; Pilipenko, V.; Ridley, A. J.; Weygand, J. M.; (2011), Statistical study of the effect of ULF fluctuations in the IMF on the cross polar cap potential drop for northward IMF, Journal of Geophysical Research: Space Physics, Volume 116, Issue A10, CitelD A10311, doi: 10.1029/2011JA016931