Extreme Poynting Flux Over the Polar Cap Region

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Introduction

We investigate several intervals of prolonged intervals of northward Interplanetary Magnetic Field (IMF) to describe the correlation between strong Poynting flux and northward IMF. We primarily focus on Summer events in each hemisphere when the polar regions are sunlit. During northward IMF the magnetic reconnection regions can form tailward of the magnetic cusp, while during southward IMF they form near the sub solar point. Using data from the Defense Meteorological Satellite Program (DMSP) F13, F15 and F16 spacecraft we looked for areas of strong Poynting flux over the magnetic polar cap regions. Values ranging from 20 mW/m^2 to 140 mW/m^2 were measured in narrow channels, showing there can be significant energy transport to small concentrated region near the magnetic pole. These areas are generally thought of as quiet but our result says quite the opposite under specific conditions.

What is Known

- Fig.1 is assuming merging with generic southward IMF.
- Under southward IMF we get magnetic reconnection regions on the dayside. (See Fig. 1)
- These reconnection regions are caused my anti-parallel field lines.
- Merging or reconnection allows for energy transfer from the Solar Wind to Earth's magnetic domain.

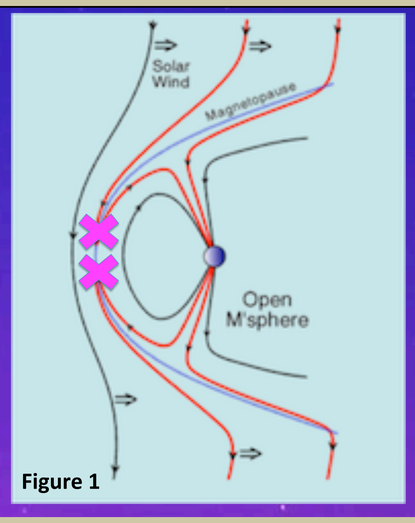
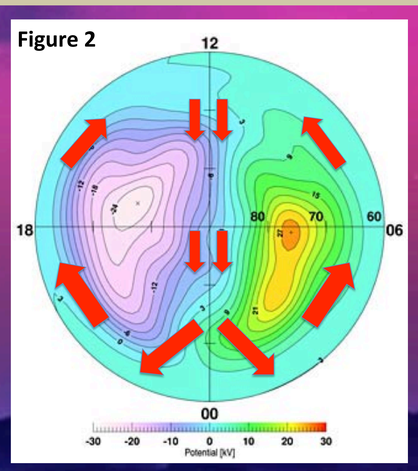


Figure 1

Southward IMF Convection Patterns

- Generally a well understood phenomena.
- Fig. 2 represents the generic convection patterns in the ionosphere. Depending on the Y component of the IMF this pattern can become more distorted.
- These patterns of plasma flow are formed by the energy transfer from the Solar wind to Earth's magnetic field lines.
- These currents close across the ionosphere and exit at a different location.
- Much of the current closure defines Earths auroral zones.

Figure 2



Methodology

- 12 Separate events were investigated.
- All events are during Northward IMF
- DMSP F13 F15 F16 spacecraft's were used. (See Fig. 3 & 4)
- Due to the sun-synchronous locations of the spacecrafts, we noticed that the most easily observed events were between 16 – 24UT.
- Our focus was on Northern Hemisphere Summer and Southern Hemisphere Summer.
- Poynting Flux is derived, not a direct measurement from DMSP.

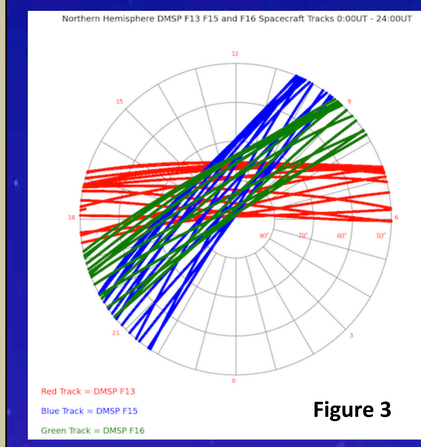


Figure 3

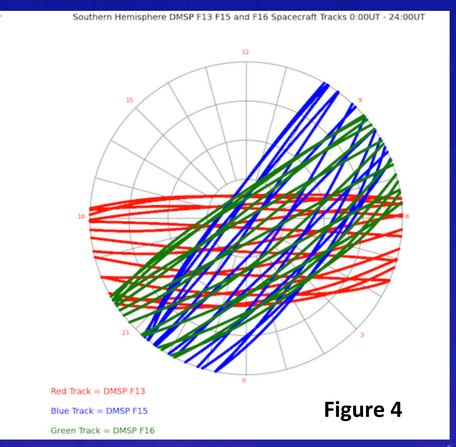
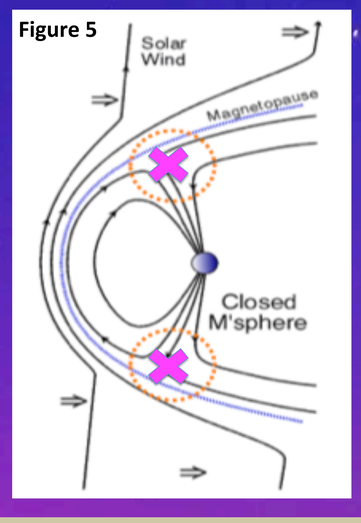


Figure 4

Generic Northward IMF

- Not understood as well as Southward IMF.
- Magnetic reconnection regions occur at higher latitudes and more tailward. (See Fig. 5)

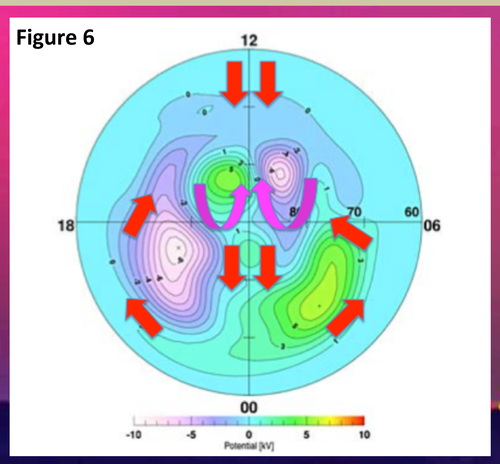
Figure 5



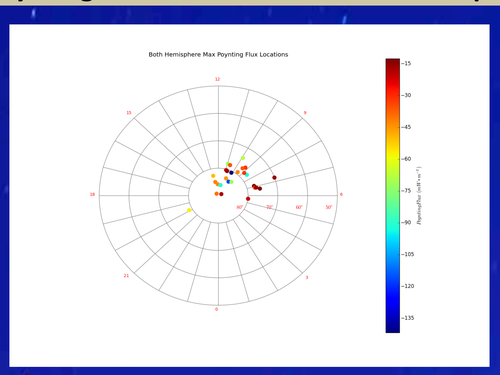
Northward IMF Convection Patterns

- Harder to detect and predict these patterns compared to Southward IMF convection patterns.
- The magnetic reconnection regions are now closer to the cusp and allow for these reverse convection cells to build in. (See Fig. 6)
- Seems that the energy is delivered to the polar cap, which is poleward of the auroral zones.
- Much stronger seasonal dependence for these events.

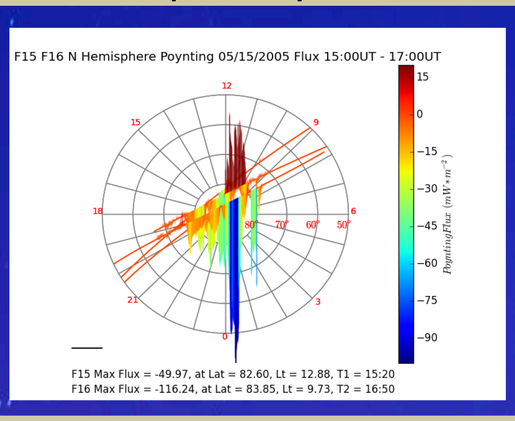
Figure 6



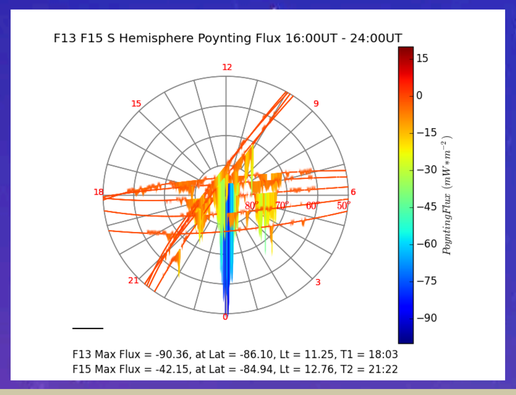
Max Poynting Flux Values From Both Hemispheres



Northern Hemisphere May 15th 2005 Event

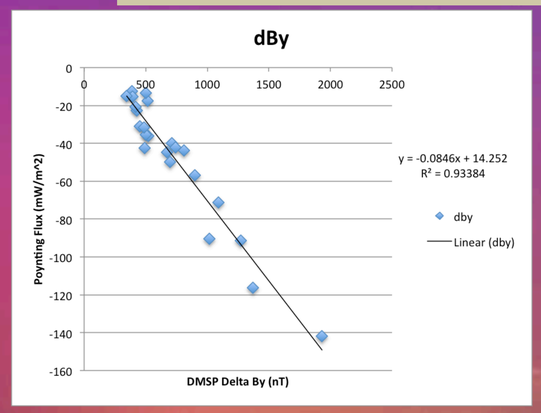


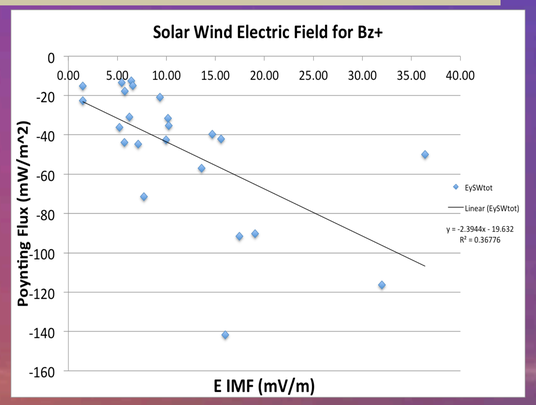
Southern Hemisphere November 24th 2001 Event



Conclusions

- Poynting flux deposition during northward IMF can be extreme.
- The primary responding parameter is Low Earth Orbit (LEO) Delta By (eastward dB) associated with field aligned currents.
- An external driver is the fast delivery of the transverse IMF that has a good correlation with Poynting Flux.
- The next step in this project will be to look at a lot larger sample size of events that meet our parameterizations.





Acknowledgements

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