Categorization of Cusp Structures in the Magnetosphere

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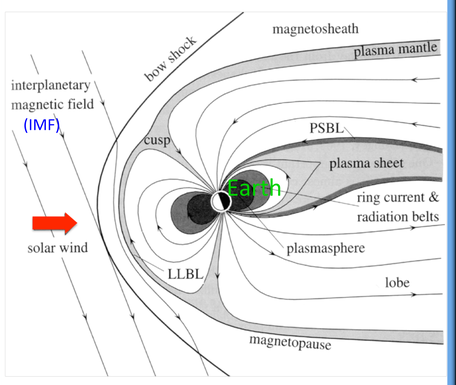
Introduction

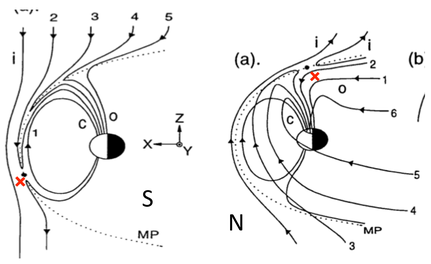
The goal of my project was to look at the data from the POLAR, ACE and WIND satellites to categorize cusp crossing data. Then compare shear data with solar wind data to look for a correlation between the two parameters. To accomplish this, my project was divided into four different tasks, in which I looked at different facets of the project.

Background

Magnetic reconnection occurs in the magnetopause due to the merging of geomagnetic field lines with interplanetary magnetic field (IMF) lines. This allows solar wind plasma to stream into the magnetopause at the cusps.



The location of reconnection at the magnetopause is determined primarily by the direction of the IMF.



A Southward IMF gives reconnection in on the dayside, and a Northward IMF gives reconnection poleward of the cusps.

Tasks

Task I:

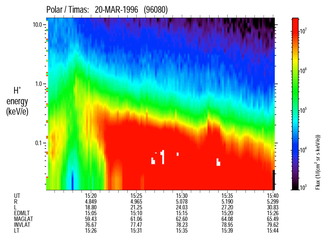
Goal: Organize and categorize POLAR cusp crossing data based on the following criteria. Combine with solar wind data to find trends.

Type 1:
- Smooth structure, no jagged peaks
- One dispersion per plot

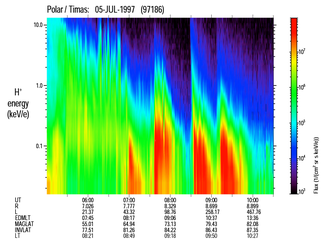
Type 2:
- More than one smooth dispersion per plot
- Distinct time gap between dispersions

Type 3:
- "None of the Above"

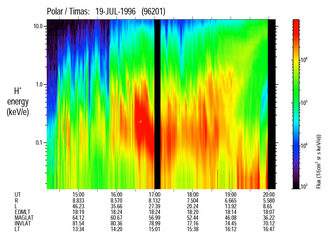
Type 4:
- Flat top and straight sides



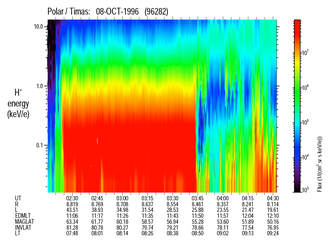
Type 1: Single Smooth



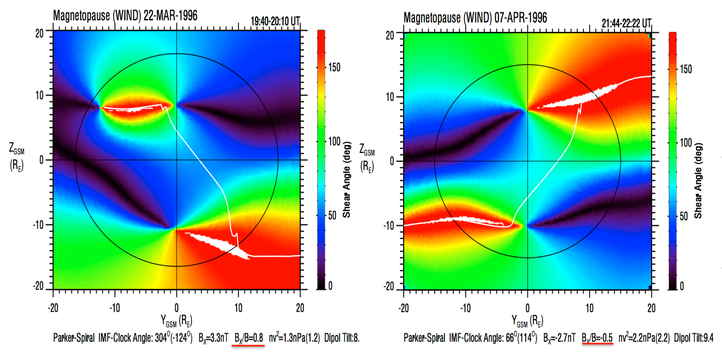
Type 2: Multiple



Type 3: Structured



Type 4: Box



Task II:

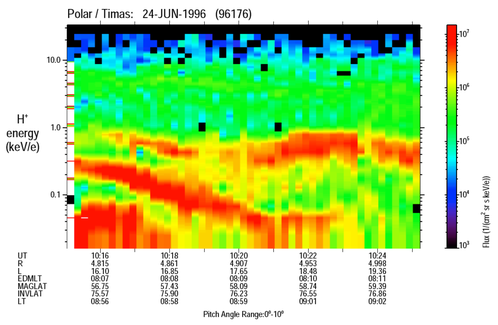
Goal: Find the transition region when the S. dispersion becomes the N. Box. Compare cusp crossing data with MP Shear plots.

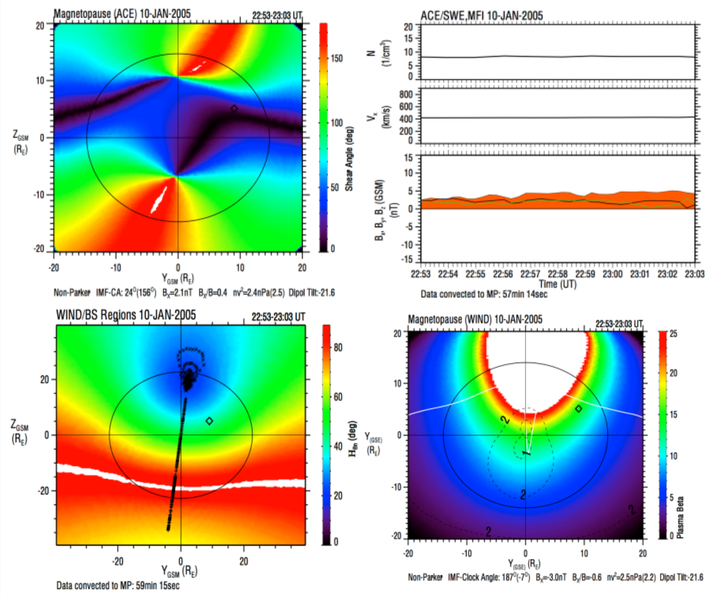
- Use only plots with clock angles between 55° and 95°, 265° and 305° (IMF switches from S to N)
- Divide plots into two categories:
  - "Large IMF" $B_x/B \geq 0.7$
  - "Event" $B_x/B < 0.7$

Task III:

Goal: Examine POLAR cusp crossing data in more detail to determine the existence of high flux overlap. Combine with solar wind data to find any trends.

- Use POLAR color spectrograms divided into 10-minute segments to identify overlap
- Overlap indicates that multiple reconnection has occurred.





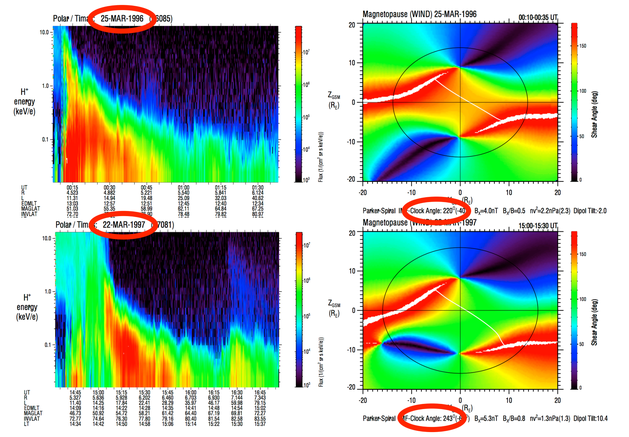
Task IV:

Goal: Generate plots using IDL for reconnection events (data provided by Double Star satellites). Look for trends between plots and check the accuracy of the reconnection location model.

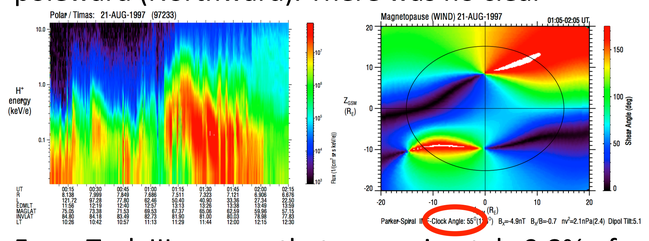
- Use event times to generate the MP shear, solar wind, and beta plasma plots
- Add the bow shock plots for events in which the satellite saw a "beam switch"
- Make all plots for both the ACE and WIND satellites
- Use time scale of ± 5 minutes about event time (unless otherwise noted)
- Record the shear, beta and Alfven Mach numbers for each

Results

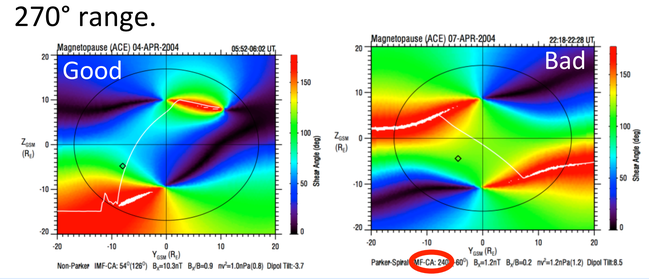
In Task 1 we found that "Smooth Single" dispersions have clock angles ranging from 220° to 270°. These types also seems to cluster near the Spring Equinox each year.



In Task II we saw that there were many plots within the angle range that showed dayside (Southward) reconnection, when they should have poleward (Northward). There was no clear



From Task III we saw that approximately 9.8% of these segmented plots contained multiple reconnections, about 24.5% of the events total. In Task IV, we found that most of our model predictions matched with the actual location of reconnection. Those that didn't match, the "anomalies," all had clock angles in the 220° to 270° range.



Conclusion

Overall, each task proved to be quite doable in the given amount of time. As well as each task providing some useful information that may help us to understand magnetic reconnection.

References

[1]Mentors: Karlheinz Trattner and Bill Peterson
[2]Trattner, K. J., S. M. Petrinec, S. A. Fuselier, N. Omidi, and D. G. Sibeck (2012), *Evidence of multiple reconnection lines at the magnetopause from cusp observations*, J. Geophys. Res., 117, A01213, doi:10.1029/2011JA017080.