Solar Wind Drivers of Auroral Omega Bands

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Introduction

- The aurora is an example of space weather at Earth
- Space weather is driven by energy transfer by the solar wind
- The solar wind is plasma that is constantly emitted by the sun, and features quasi-periodic density structures
- The magnetosphere is defined as the region near Earth that is dominated by Earth's magnetic field
- The topology of the magnetosphere is affected by the interaction between Earth's magnetic field and the solar wind

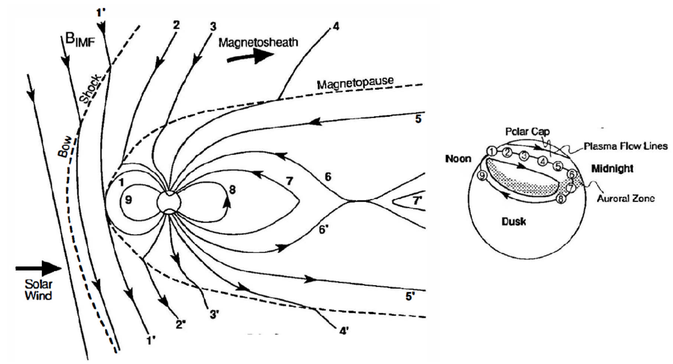
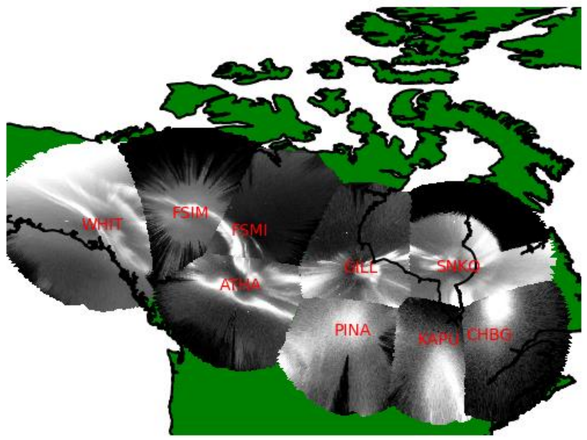


Diagram of magnetic reconnection in the magnetosphere during an interval of southward-oriented IMF (Kivelson & Russell, 1995)

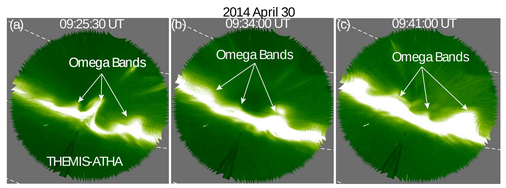
- When the solar wind magnetic field (IMF) is oriented southward, magnetic reconnection occurs in the magnetosphere, allowing particles to diffuse across magnetic field lines
- In this process, particles penetrate the magnetosphere and precipitate into the atmosphere, exciting neutral atoms
- The excitation release appears as the aurora borealis and australis
- Reconnection in the magnetotail can drive cyclic behavior in the ionosphere that appears as an auroral substorm



Auroral activity detected by THEMIS ASI cameras on 2014-04-30 at 07:30 UT

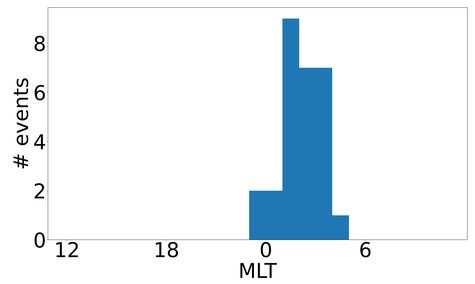
Omega Bands

- Omega (ʊ) bands are mesoscale structures in the aurora
- ʊ bands appear as eastward-moving wave-like structures in the poleward edge of the equatorward auroral oval
- Typically observed in the post-midnight sector



Omega bands seen over Athabasca on 2014-04-30

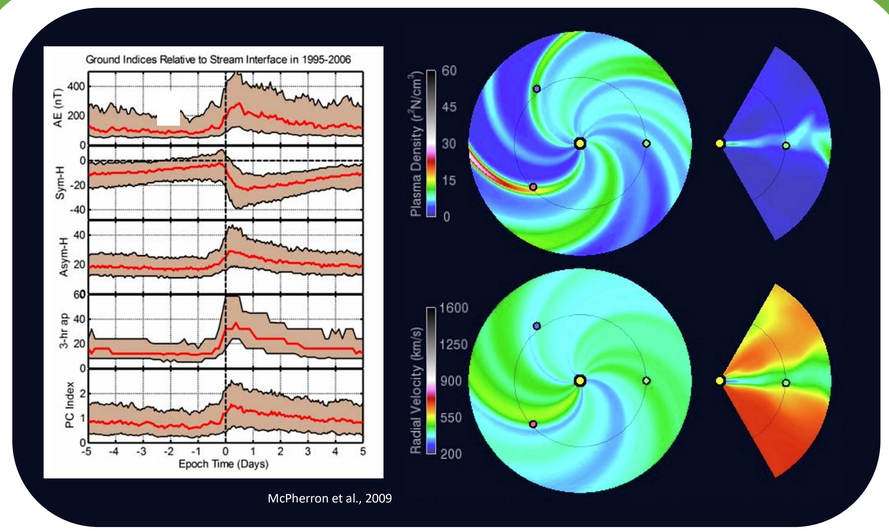
- Historically seen during geomagnetically active conditions, but the magnetospheric state in which ʊ bands appear is unknown
- Possible drivers include Earthward bursty bulk flows (BBFs) in the magnetotail and Kelvin-Helmholtz (KH) instability in the plasma sheet
- Previous statistical studies of ʊ bands focus on ionospheric and ground-based measurements
- In this work, we perform a superposed epoch analysis of solar wind and magnetospheric data from ʊ band events to evaluate their driving mechanisms
- **We examine 28 ʊ band events from 2006 to 2013**

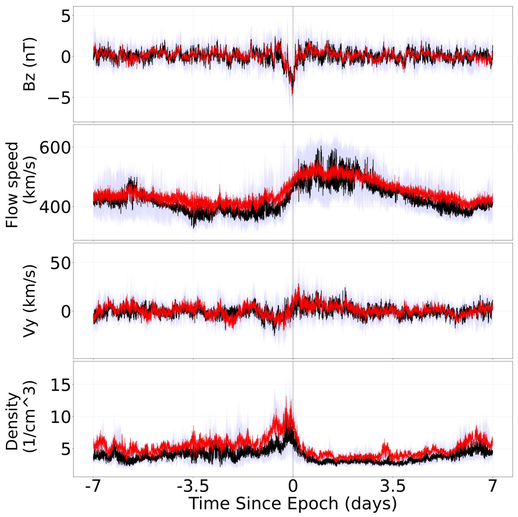


MLT distribution of ʊ band events used in this study

Instrumentation

- For this analysis, we use THEMIS ASI keograms to identify a list of ʊ band events
- We use OMNI solar wind measurements and SuperMAG (Gjerloev, 2012) auroral electrojet measurements for the statistical analysis





From top to bottom, a superposed epoch analysis of OMNI IMF, flow speed, and pressure measurements of the solar wind taken during our 28 events. The analysis spans 2 weeks, where time zero indicates the ʊ band observation. Median values are black, mean values are red, and interquartile ranges are gray in all plots.

- In our superposed epoch analysis, we see a rotation in the IMF and enhanced solar wind velocity and pressure corresponding to our ʊ band observations
- This is very similar to the measurements expected for stream interaction regions (SIRs) in the solar wind
- SIRs form when a fast solar wind stream overtakes a slow leading stream
- 19 of our 28 events appear during time intervals on published lists of SIRs

Our superposed epoch analysis indicates ʊ bands are driven by compression regions commonly associated with SIRs.

Acknowledgements

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