A Statistical Analysis of Pedersen Conductivity
In SAPS Regions

Farzan Beroz
Duke University
MIT Haystack Observatory REU 2009 Program
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Sub-Auroral Polarization Streams

- Areas of dense, moving plasma
- Motion from lower latitudes to higher latitudes
- Caused by coupling of ionosphere and magnetosphere
- Edges cause space weather effects
Survey Methodology

- Millstone Hill radar scans used
- Existing database of ~1200 identified SAPS events from 1979-2001
- Improved, class-based organization

Line-of-sight ion velocity
Yellow = 0 m/s  Blue = 1000 m/s away
Pedersen Conductivity

\[
\sigma_P = \frac{n_e q}{B} \left[ \frac{\omega_{ci} \nu}{(v^2 + \omega_{ci}^2)} - \frac{\omega_{ce} \nu}{(v^2 + \omega_{ce}^2)} \right]
\]

- ionospheric electron density
- neutral density
- ion-neutral collision frequency
- magnetic field strength

Red: measured by ISR
Green: modeled

= electric current

To Magnetosphere \[ \vec{B}(\Lambda) \vec{B}(\Lambda + \Delta\Lambda) \]

Ionosphere

Ideal radar (points up B)
Millstone Hill radar (scans across B)
Altitude threads

Yellow: SAPS midpoint
Altitude threads

Thread = line of constant mag. lat. (mag longitude varies)
Altitude and Pedersen Conductivity

- Graph is made from one “thread”
- Blue point is SAPS midpoint
- Integrated value calculated using trapezoidal integration
Altitude and Pedersen Conductivity

Theoretical Pedersen conductivity profile

[Kelley, 1989]
Altitude and Pedersen Conductivity

- Graph is made from one “thread”
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Altitude threads

Thread = line of constant mag. lat. (mag longitude varies)
Altitude threads

Thread = line of constant mag. lat. (mag longitude varies)
Magnetic Latitude and Integrated Pedersen Conductivity

- Graph is made from multiple “threads” from one scan
- Each point is the integral of the thread’s Pedersen conductivity from 300 to 500 km
- Blue point is integrated value of the thread that runs through the midpoint
• Data from 350~ scans binned by time
• SAPS integrated conductivity decreases from day to night
Altitude threads

Thread = line of constant mag. lat. (mag longitude varies)
Integrated Pedersen Conductivity Inside and Outside SAPS

• Each graph shows the integrated Pedersen conductivity curves at the midpoint and three degrees equator-ward

• Integrated Pedersen conductivity at SAPS midpoint is 2x lower

• SAPS electron density peaks at higher altitudes: collisions with neutrals decrease, causing lower conductivity
Summary

- Millstone Hill radar was used to create a unique database for SAPS studies
- Flexible software toolkit constructed
- Measured Pedersen conductivity values behave similar to predictions made using theoretical models
- Integrated Pedersen conductivity depends on location, time of day and proximity to Sub-Auroral Polarization Streams
- Lower integrated Pedersen conductivity is observed near SAPS channel midpoints
Future Work

- Finish error propagation once available from Madrigal
- Improved thread interpolation and integration
- Enhanced statistical study after September NASA conference
- Correlate variations in Pedersen conductance with SAPS velocity
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Altitude vs Electron Density at Magnetic Latitude = 60.67

Scan Number: 997
Midpoint date and time: 1990-09-20 21:35:20
Magnetic Latitude vs Integrated Pedersen Conductivity

Scan Number: 1004
Midpoint date and time: 1990-09-21 09:08:46 (UTC)
Altitude Range: 300 to 500 (km)
Slope: -0.0164291732853±5.01433064666e-07
Coefficient of Determination: 0.995725828295