

Impulsive Energy Transfer Via Joule Heating from the Magnetosphere to the Ionosphere During Geomagnetic Storms

THEME: SMALL STRUCTURE - CRITICAL

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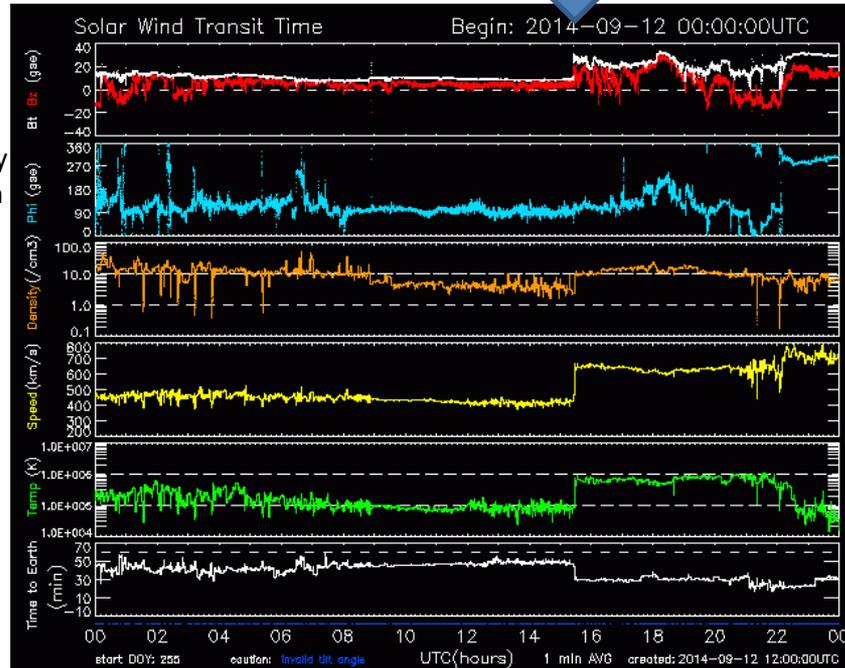
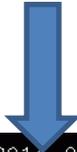
Robert Robinson, The Catholic University of America

Brian Anderson, Haje Korth, Johns Hopkins University Applied Physics Laboratory

United Nations/United States of America Workshop on
the International Space Weather Initiative

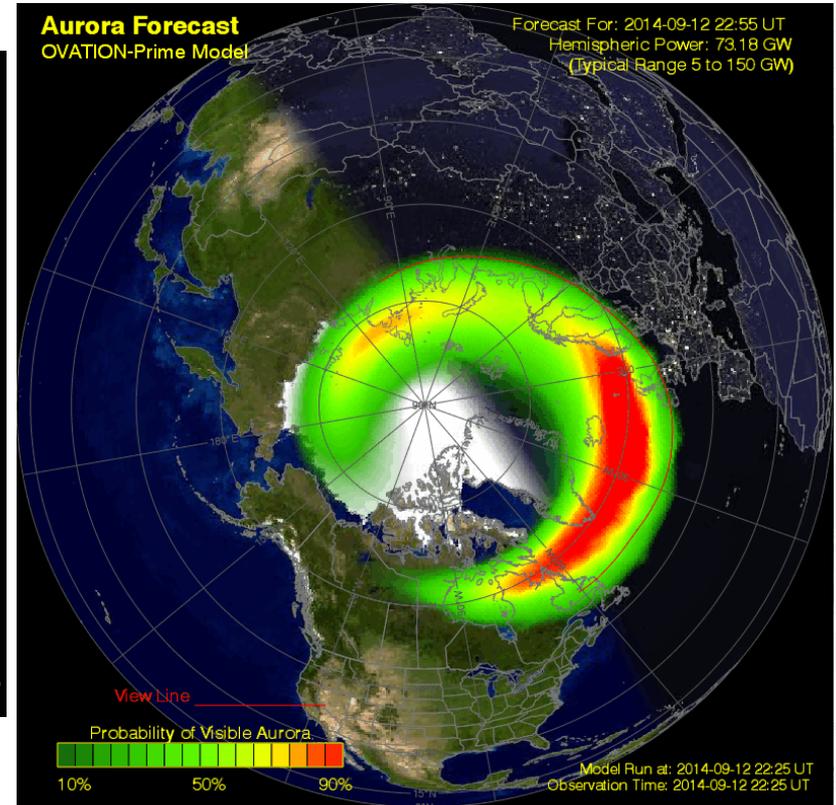
1 August, 2017 Boston College

SWFO enables warnings to customers



Magnetic field intensity and direction

Solar wind density, speed, temperature

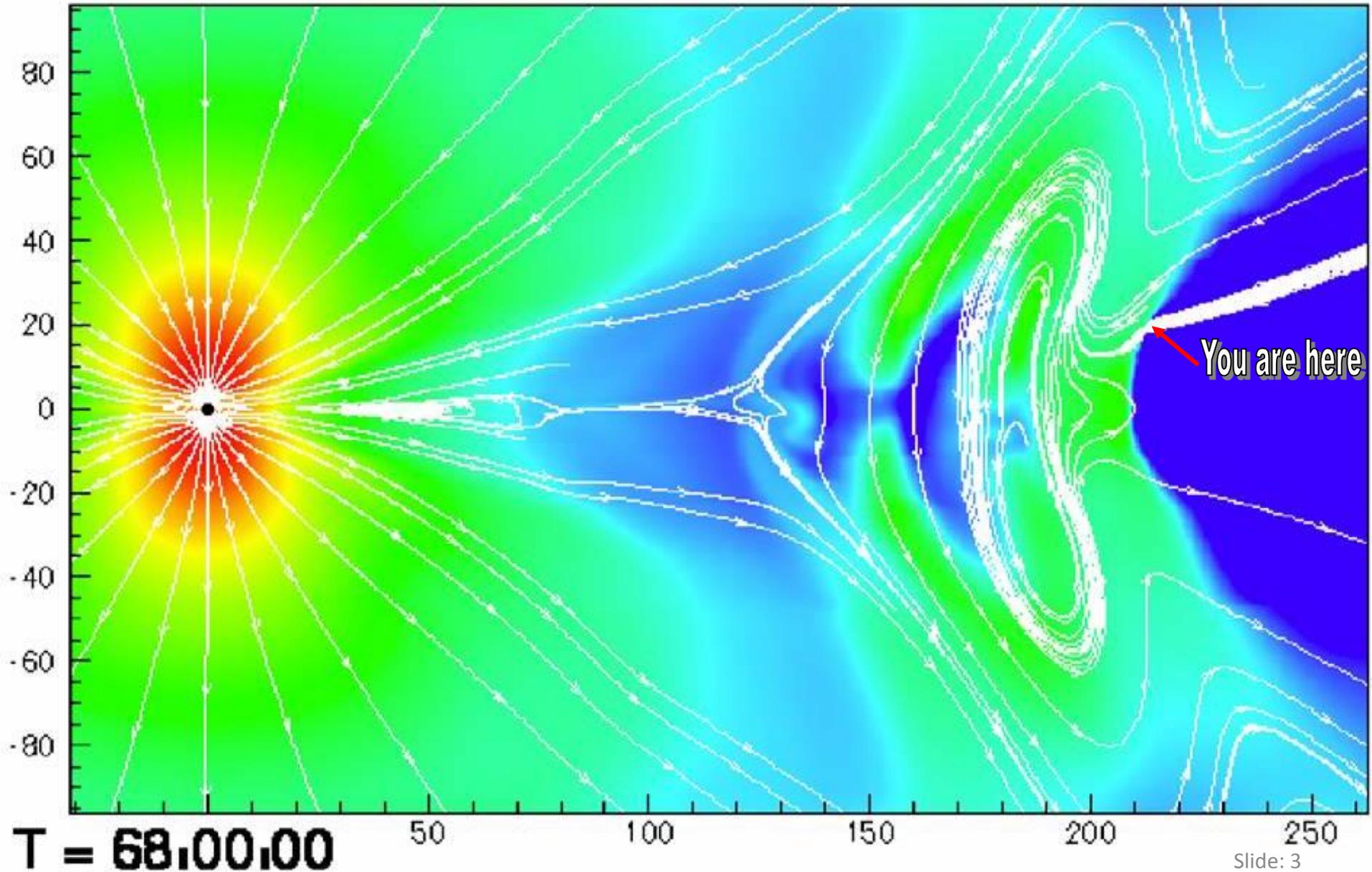


Geomagnetic storm warning and subsequent aurora

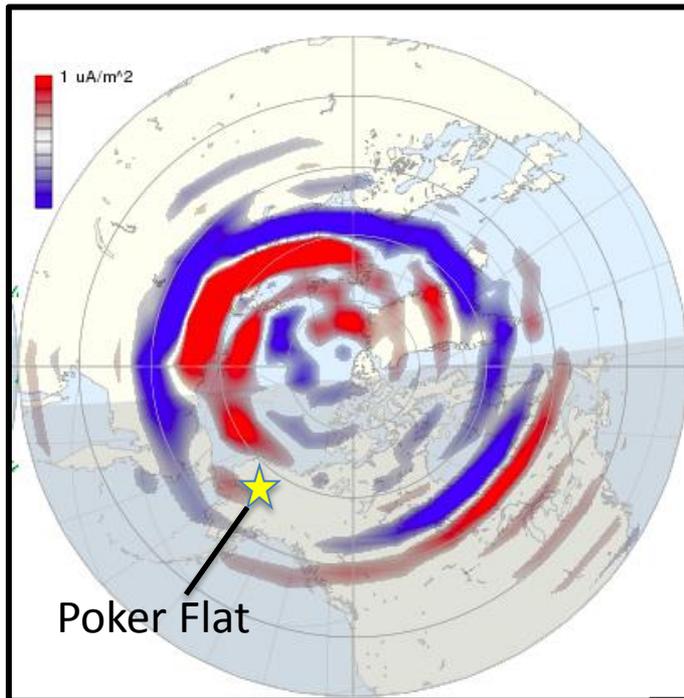
- DSCOVR data used by SWPC to issue geomagnetic storm warning to customers (blue arrow)
- SWPC Ovation forecast model shows where aurora will be visible (using DSCOVR data), also used by customers to see where impacts are likely



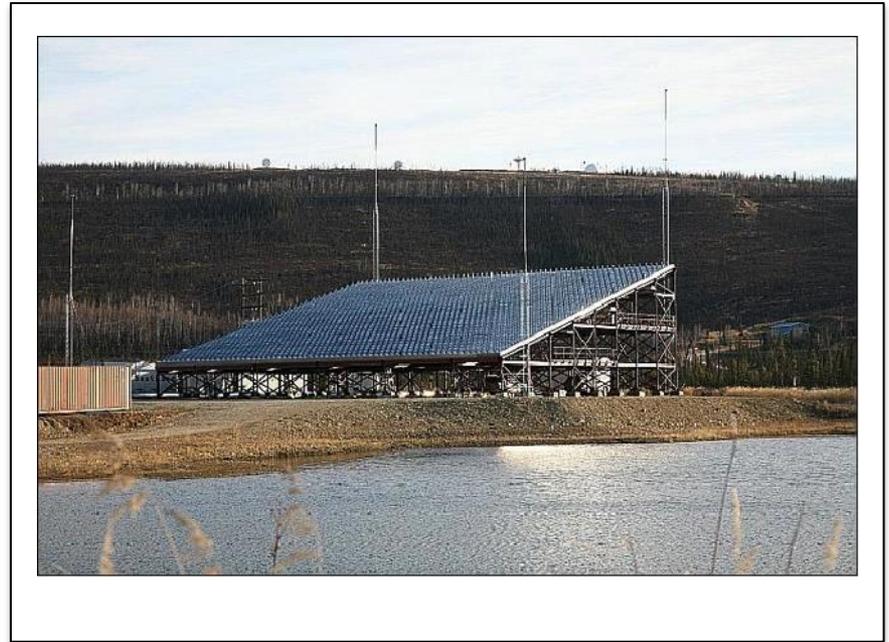
The Importance of L1



AMPERE Measurements of Field-Aligned Currents



Poker Flat Incoherent Scatter Radar measurements of ionospheric electron densities

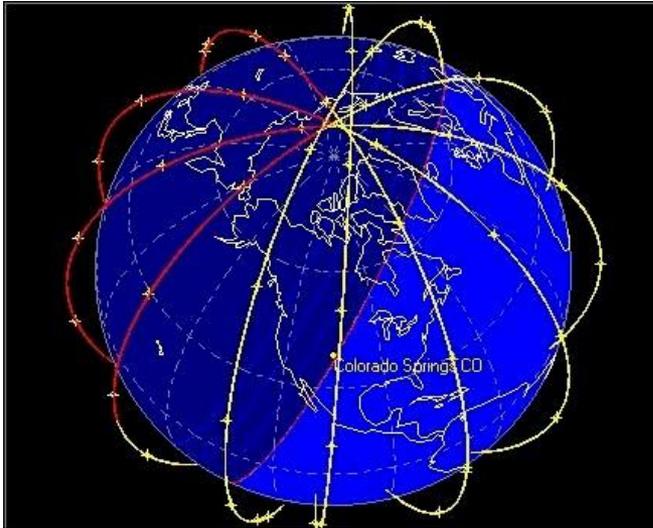


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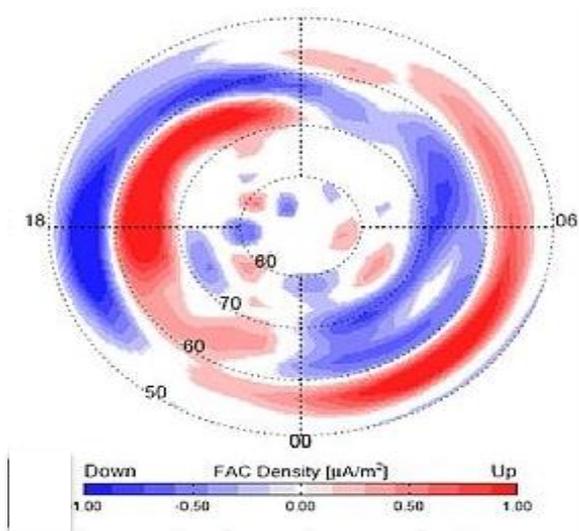
Measurements every 10 minutes
18 geomagnetically active days

2592 simultaneous and coincident measurements of height-integrated ionosphere conductivities and field-aligned currents

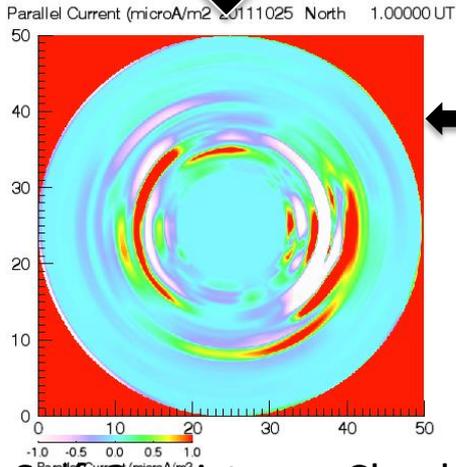
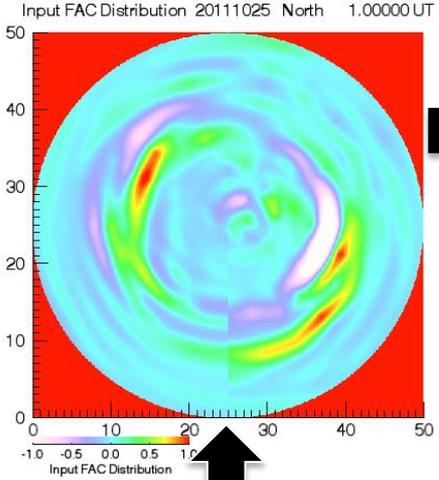
AMPERE-Derived Space Weather Products



- Aurorally-produced conductivities
- Local and hemispherically integrated auroral energy flux
- Cross Polar Cap Potential
- High latitude electric fields and currents; AE index
- Joule heating
- Ground magnetic perturbations
- Auroral electron density profiles to 300 km altitude
- Line-of-sight electron density and partial TEC
- High-latitude scintillation prediction

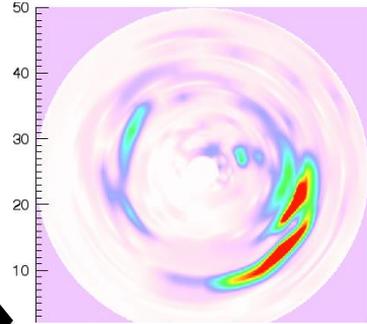


Begin with AMPERE
Field-aligned currents

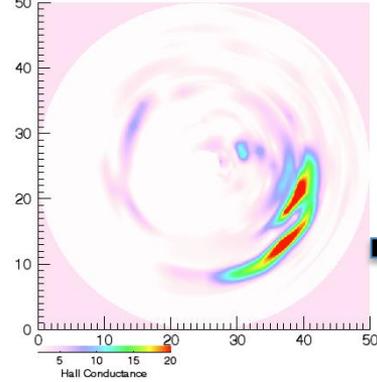


Self-Consistency Check
with Derived Field-
aligned Currents

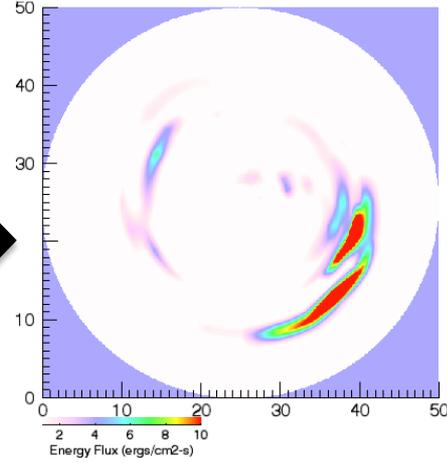
Pedersen Conductance



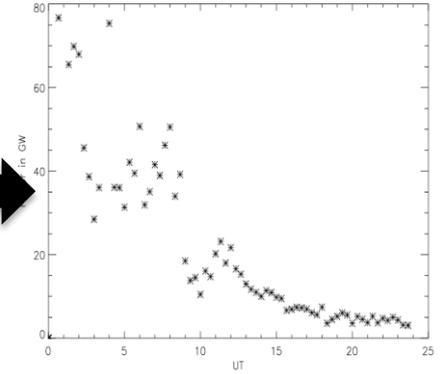
Hall Conductance



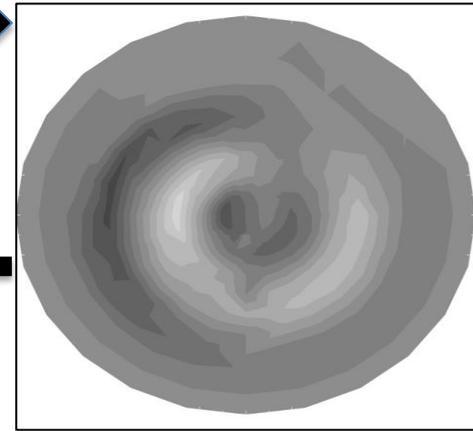
Energy Flux



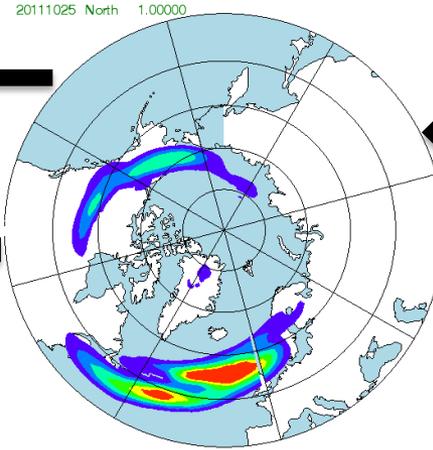
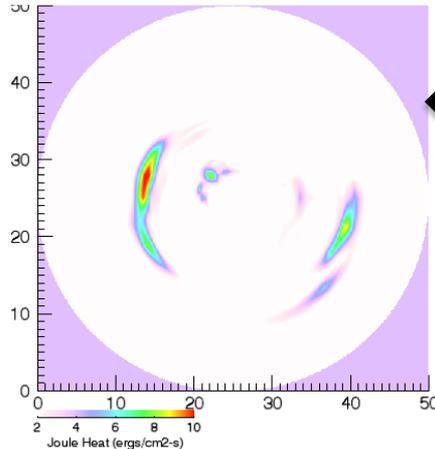
Hemispherical Power Input



Convection Pattern



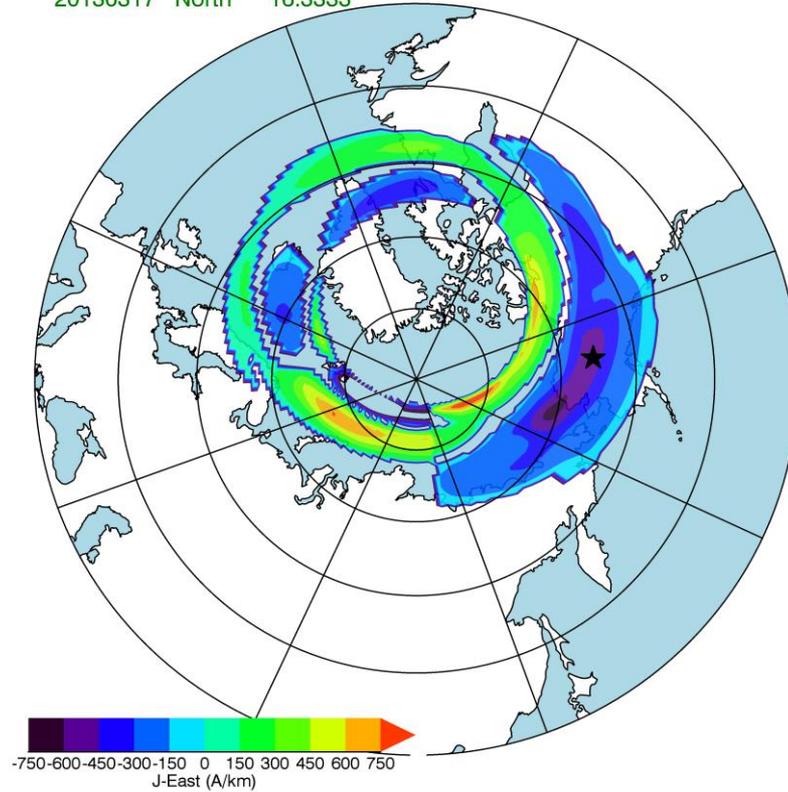
Joule Heat



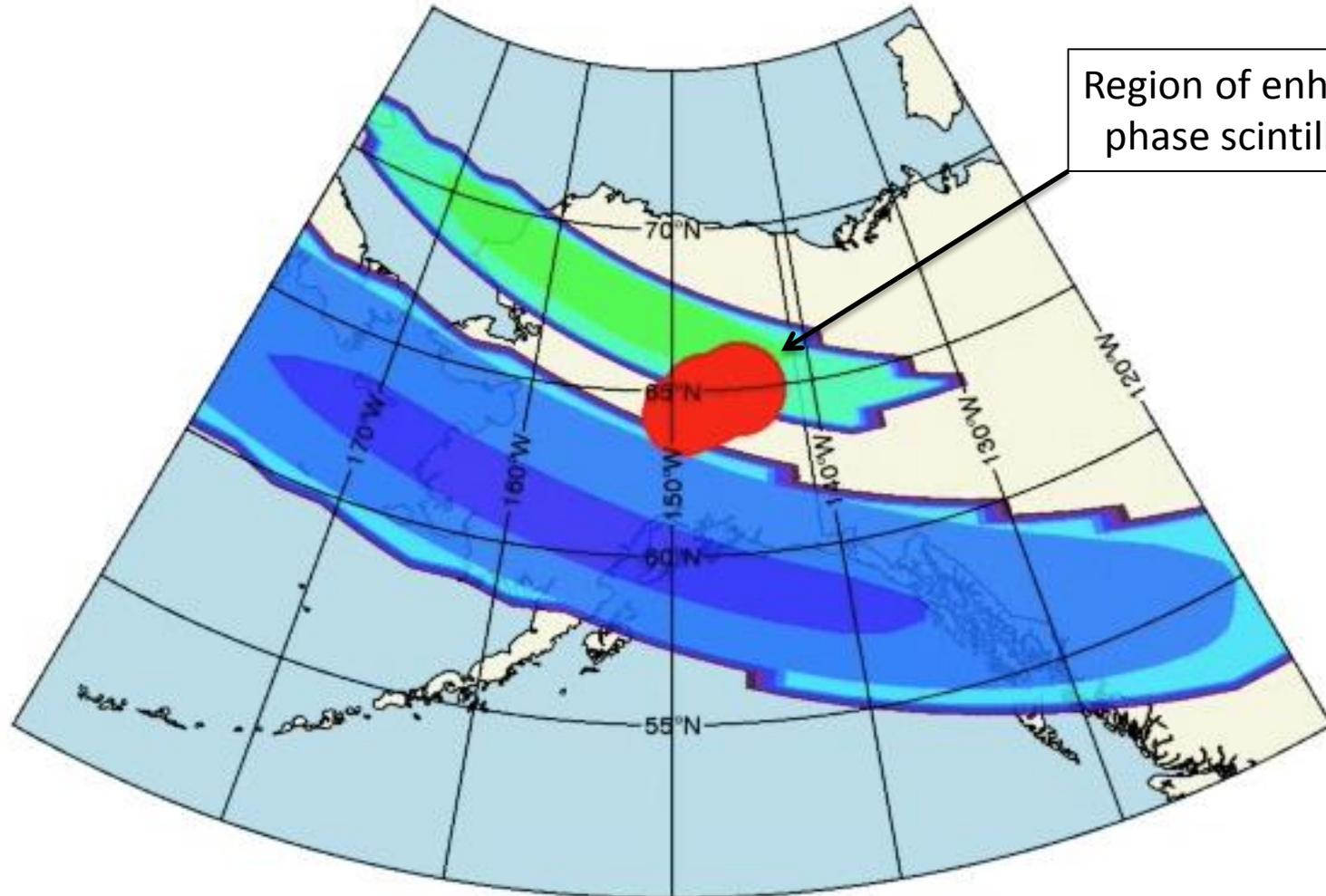
Ionospheric Currents

Geographically-Referenced Ionospheric Currents

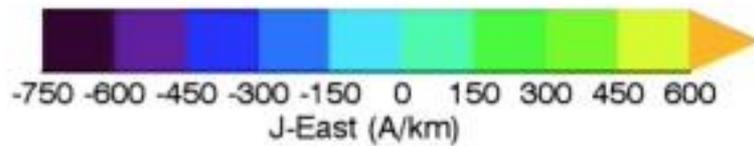
20130317 North 16.3333



20151231 North 15.3667 UT

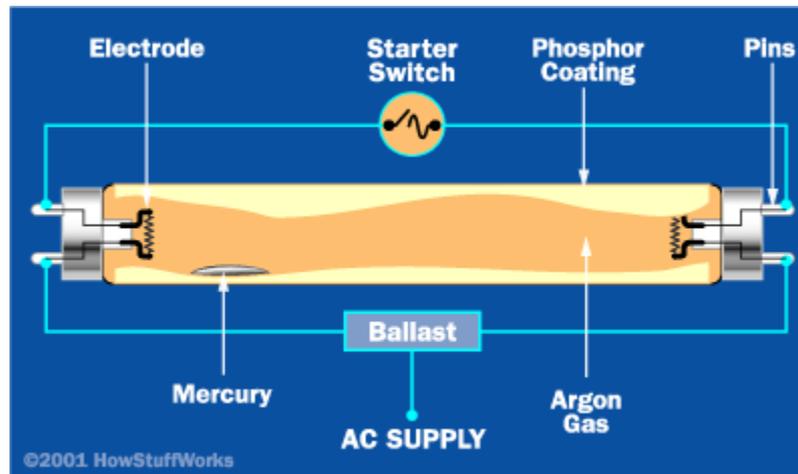


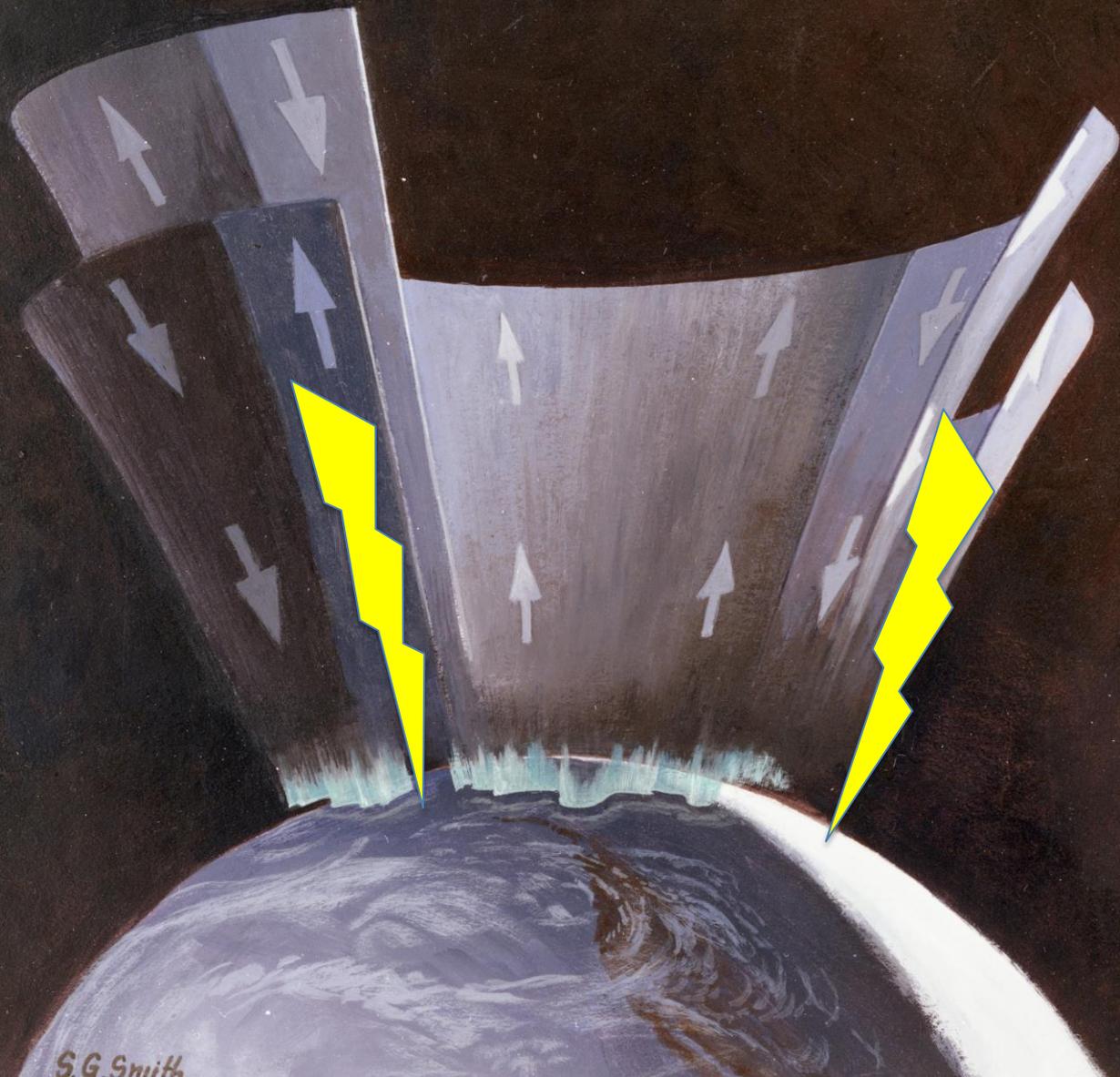
Region of enhanced phase scintillation



[Wikipedia: Negative Resistance Devices](#)

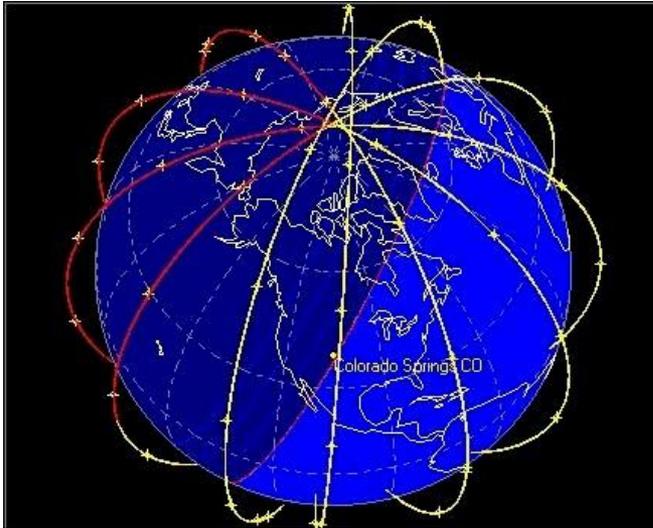
[Fluorescent lamps are differential resistance devices, so as more current flows through them, the electrical resistance of the fluorescent lamp drops, allowing for even more current to flow. Connected directly to a constant-voltage power supply, a fluorescent lamp would rapidly self-destruct due to the uncontrolled current flow. To prevent this, fluorescent lamps must use an auxiliary device, a ballast, to regulate the current flow through the lamp.](#)



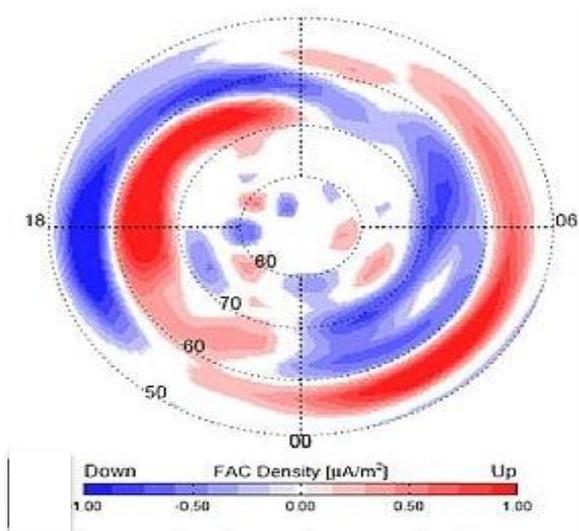


S.G. Smith

Space Weather Products: Summary

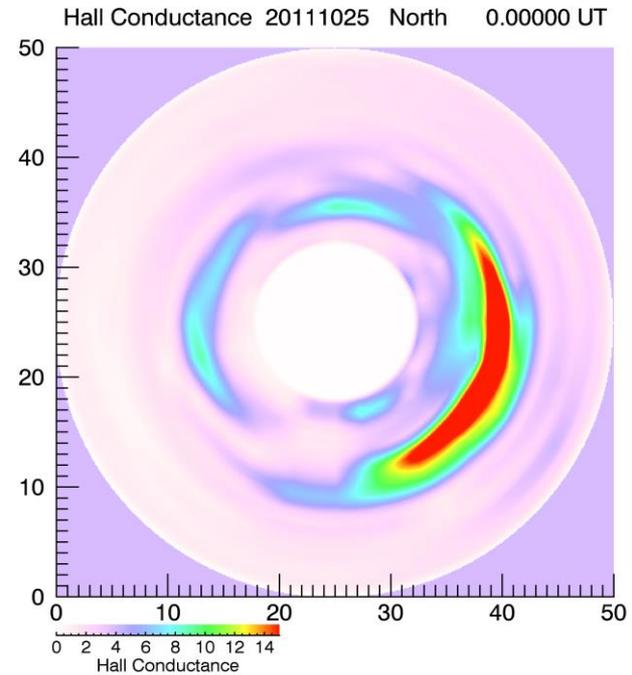
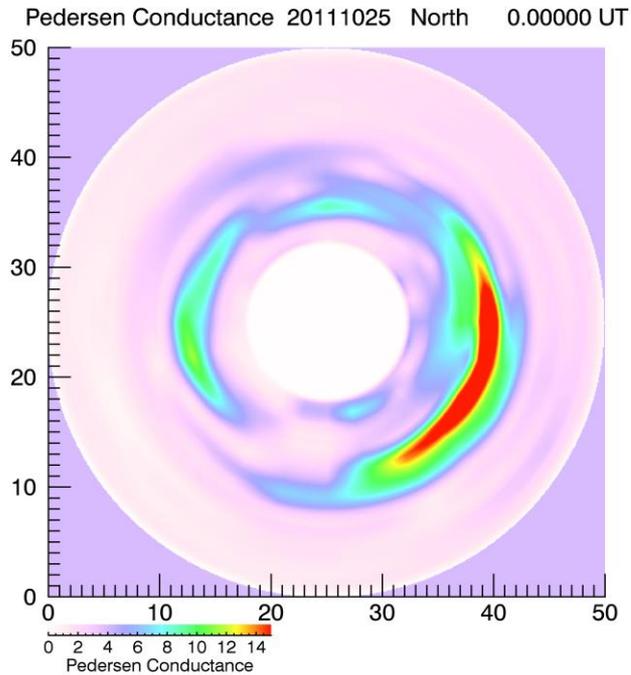


- Field-aligned current maps
- Aurorally-produced conductivities
- Joule heating
- Ground magnetic perturbations
- High-latitude scintillation prediction
- Need to capture small-scale structure for realistic space weather predictions

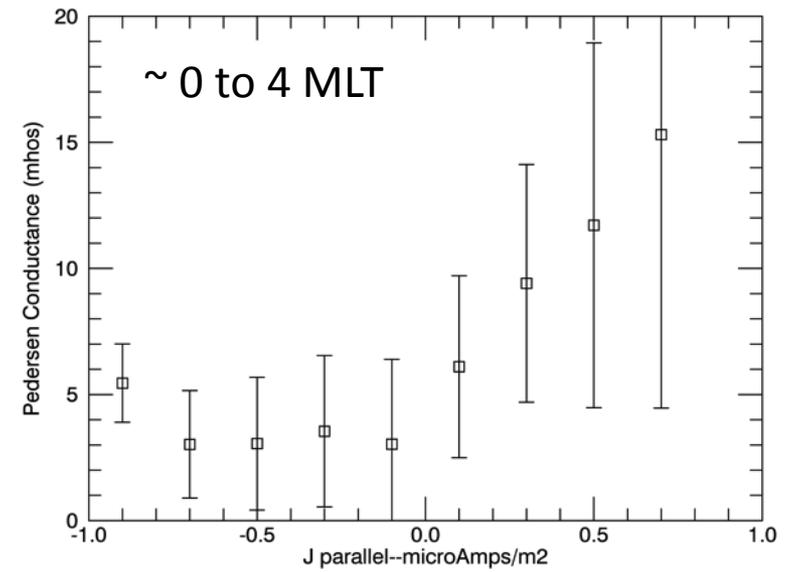
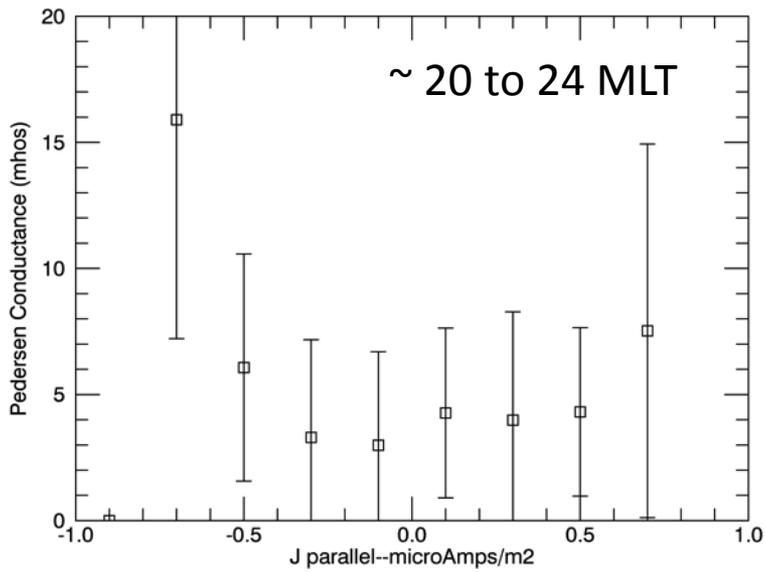
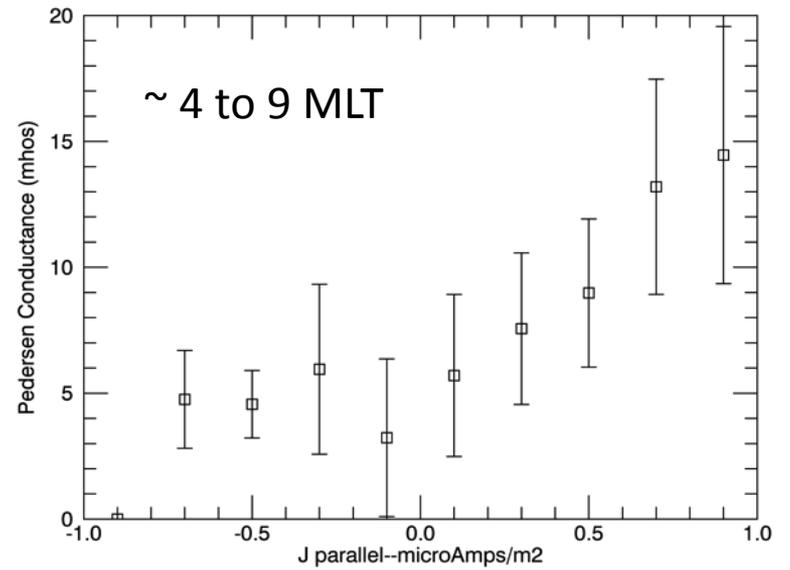
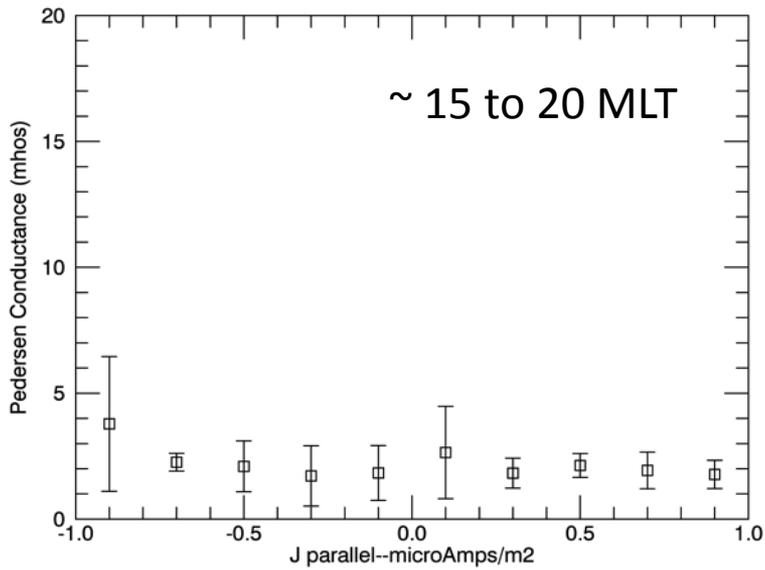


Backups

Auroral Conductivities— Updated Every 2 Minutes



Field-Aligned Currents vs. Pedersen Conductance



Conductivities derived from field-aligned currents self-consistently yield the high latitude convection pattern

