

# Conductances and Conductivities

## The Ionospheric Perspective

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# Definition of Conductivity and Conductance

Pedersen and Hall conductivity:

$$\sigma_P = \frac{N_e e}{B} \left( \sum_i \frac{v_{in} \Omega_i}{v_{in}^2 + \Omega_i^2} + \frac{v_{en} \Omega_e}{v_{en}^2 + \Omega_e^2} \right)$$

$$\sigma_H = \frac{N_e e}{B} \left( \frac{\Omega_e^2}{v_{en}^2 + \Omega_e^2} - \sum_i \frac{\Omega_i^2}{v_{in}^2 + \Omega_i^2} \right)$$

where  $v_{in}(N_{NO}, N_{O_2}, N_o, T_n, T_i)$  and  $v_{en}(N_{NO}, N_{O_2}, N_o, T_n, T_e)$  are ion-neutral and electron-neutral collision frequencies, respectively, and they depend on neutral composition and temperature.

Pedersen and Hall conductance:

$$\Sigma_P = \int \sigma_P dz \quad \text{and} \quad \Sigma_H = \int \sigma_H dz$$

# Measurements of Conductances

- IS radars:
  - Pros: most direct/accurate conductivity information
  - Cons: assumption of neutral composition; single-point measurements
- Satellite in situ precipitating particles: e.g. DMSP, NOAA
  - Pros: Improved spatial coverage across the auroral oval
  - Cons: not fully resolved energy spectral distribution; limited LT coverage
- Auroral Imagers: e.g. Polar/UVI, IMAGE/FUV, TIMED/GUVI, DMSP/SSUSI, all-sky cameras (ASC)
  - Pros: global/regional coverage
  - Cons: assuming Maxwellian distribution; coarse spatial resolution of global auroral images

# Statistical Conductance Models

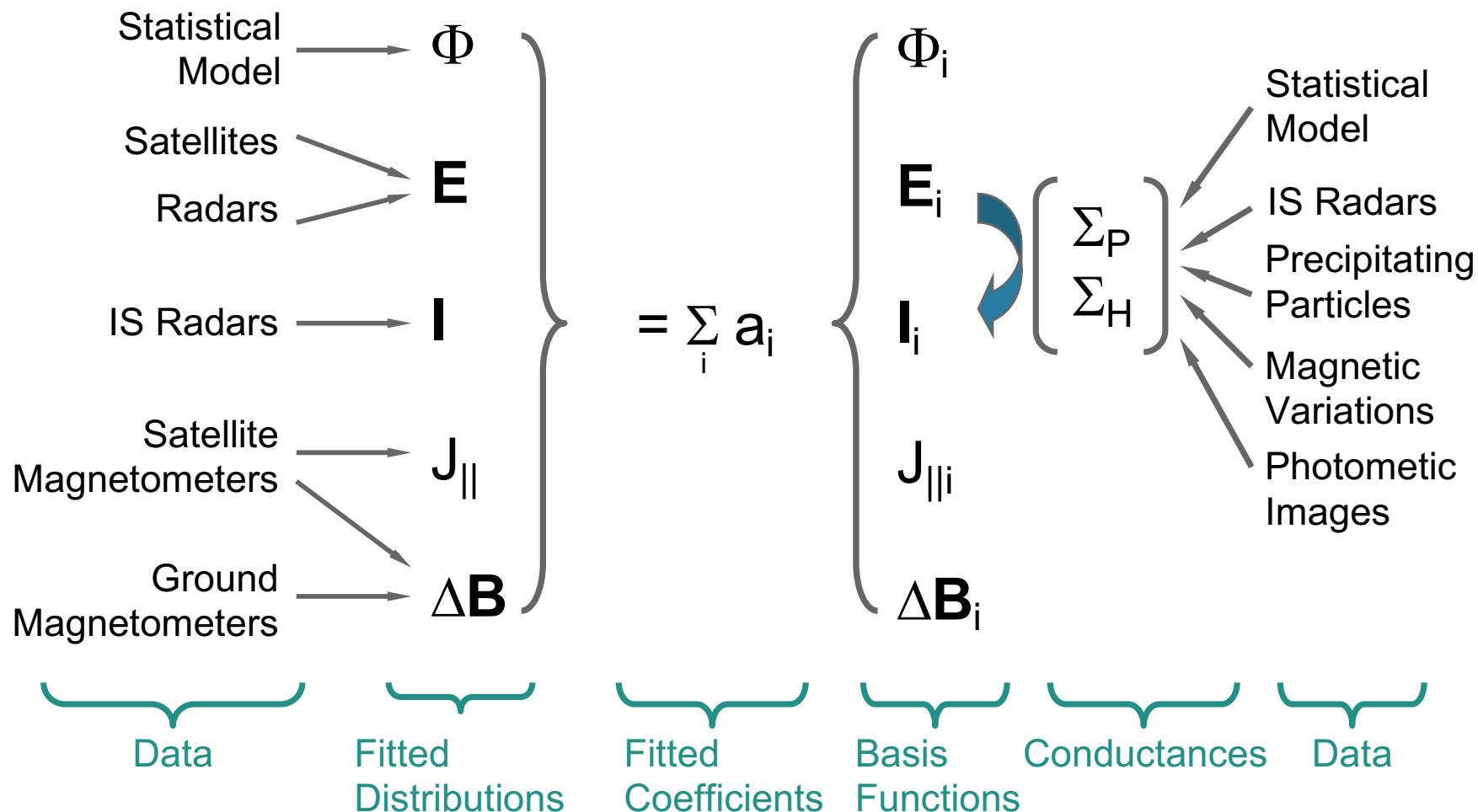
- Wallis & Budzinski (1981): based on Isis-2, Kp dependent
- Hardy et al. (1985, 1989): based on DMSP, Kp dependent
- Fuller-Rowell & Evans (1987): based on NOAA-TIROS, hemispheric power index (HPI) dependent
- Zhang & Paxton (2008): based on GUVI, Kp dependent
- Newell et al (2010, 2014): OVATION and OVATON Prime based on DMSP and GUVI, parameterized by the solar wind – magnetosphere coupling function

# Empirical Formulas for Conductances

- Ahn's formulas (1982; 1998): based on correlation between Chatanika radar and ground magnetometers
- Robinson's formulas (2019): based on correlation between PFISR radar and AMPERE FACs

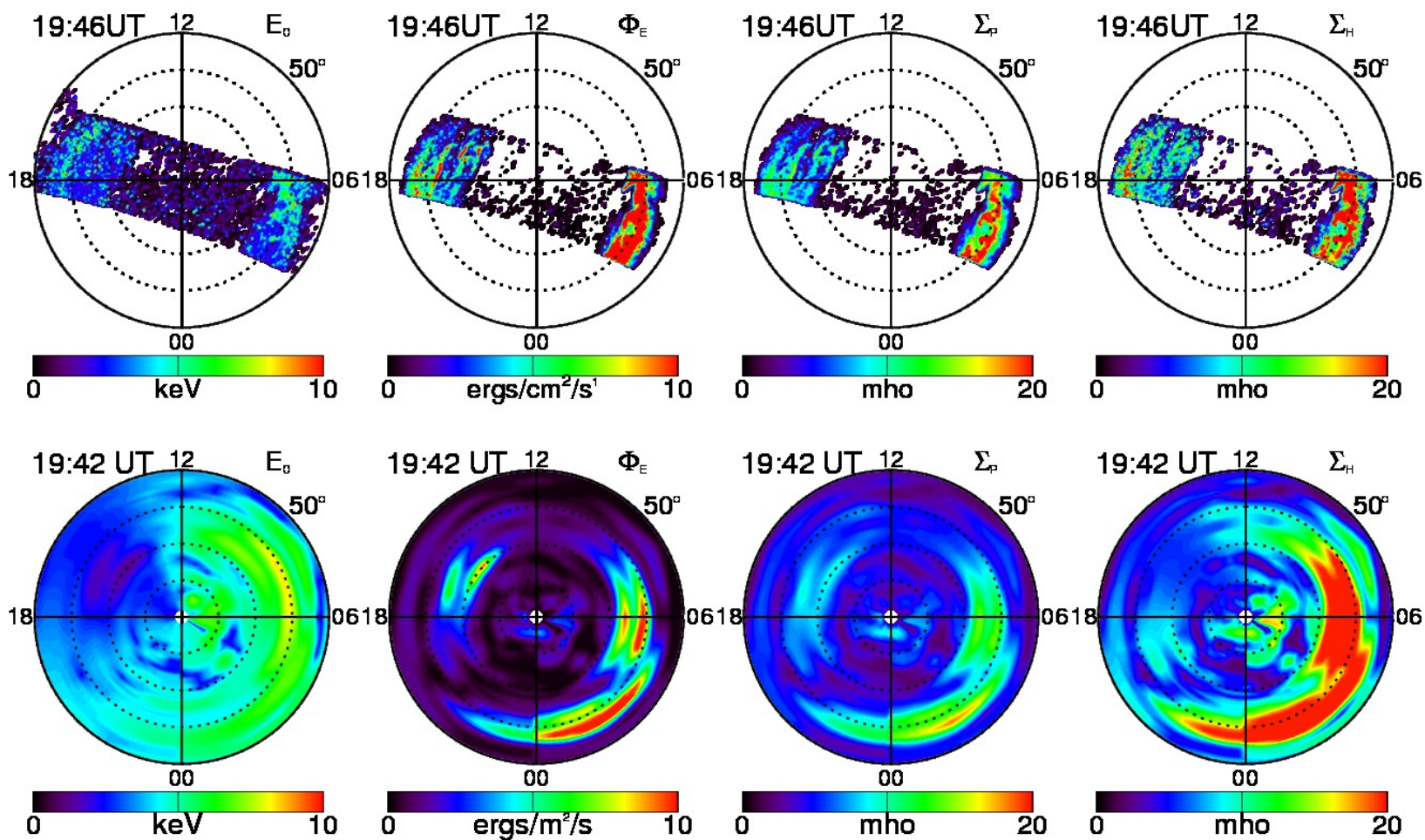
# The AMIE Procedure

(Assimilative Mapping of Ionospheric Electrodynamics)



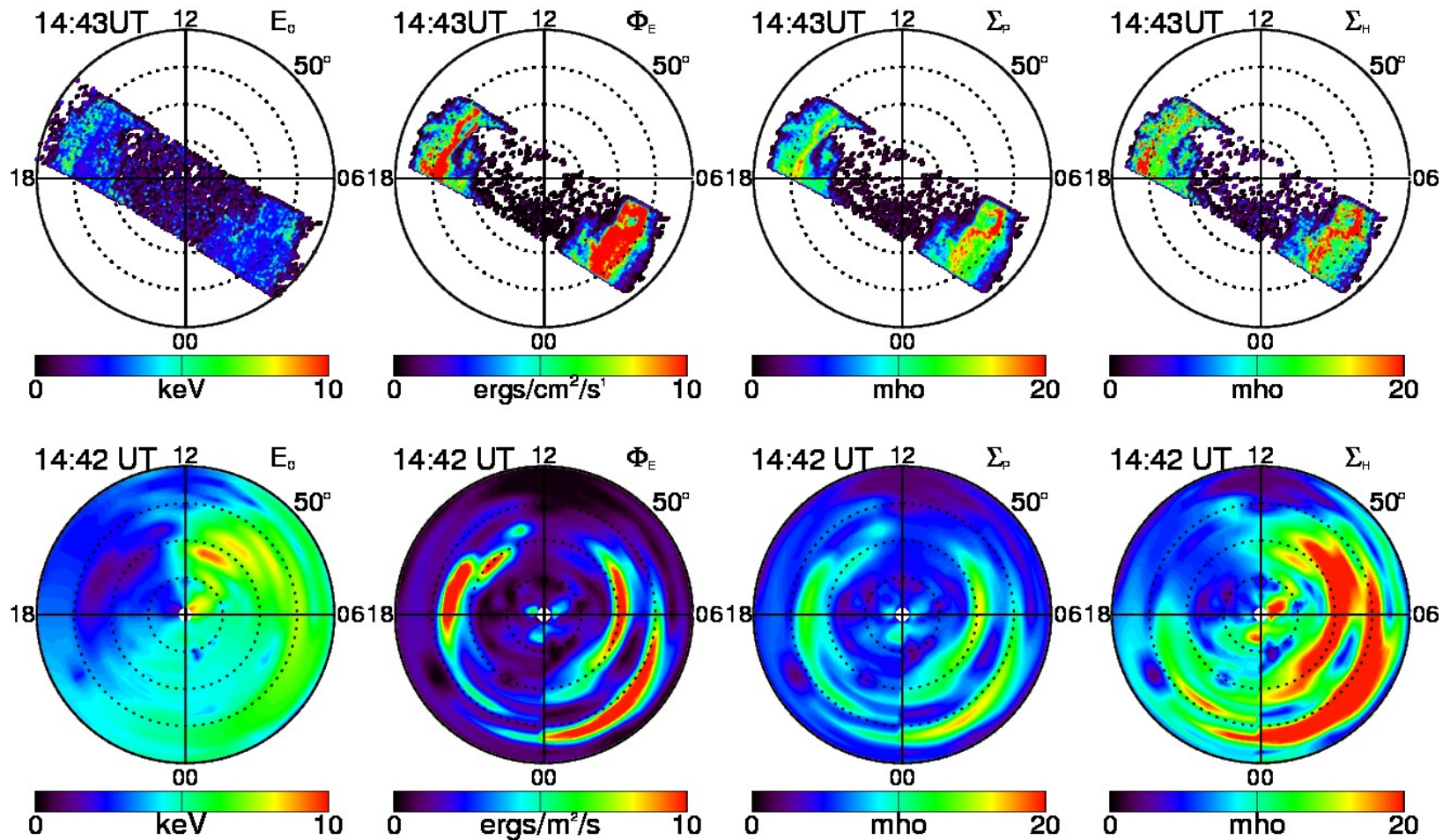
[after Richmond and Kamide, 1988]

# 2015 DAY 76 (North) F16-SSUSI: Orbit #58880



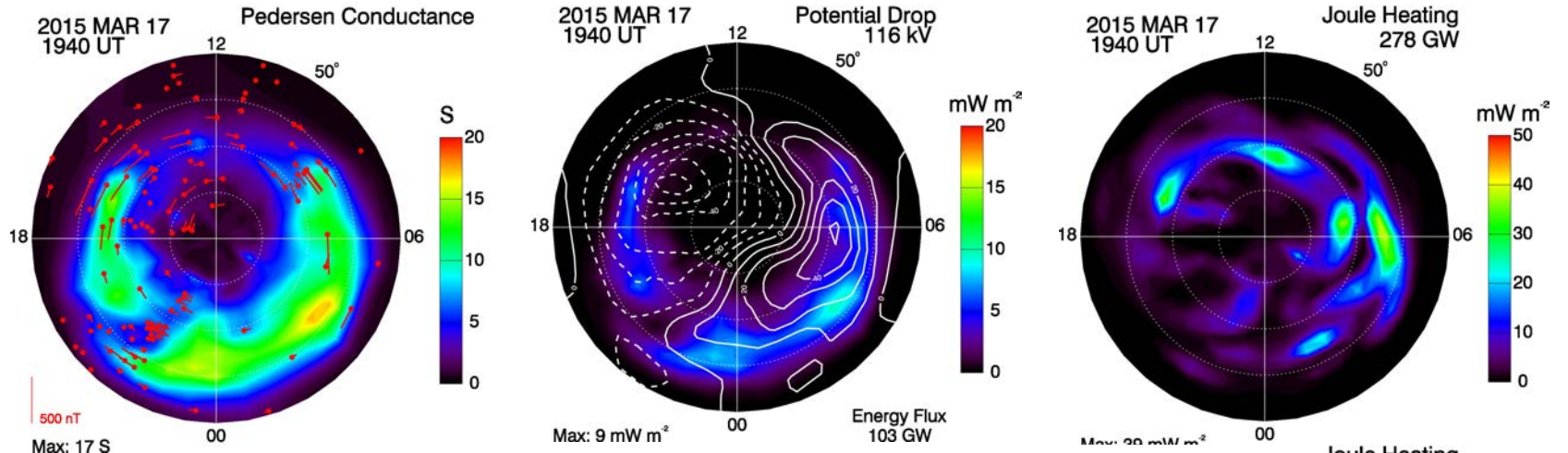


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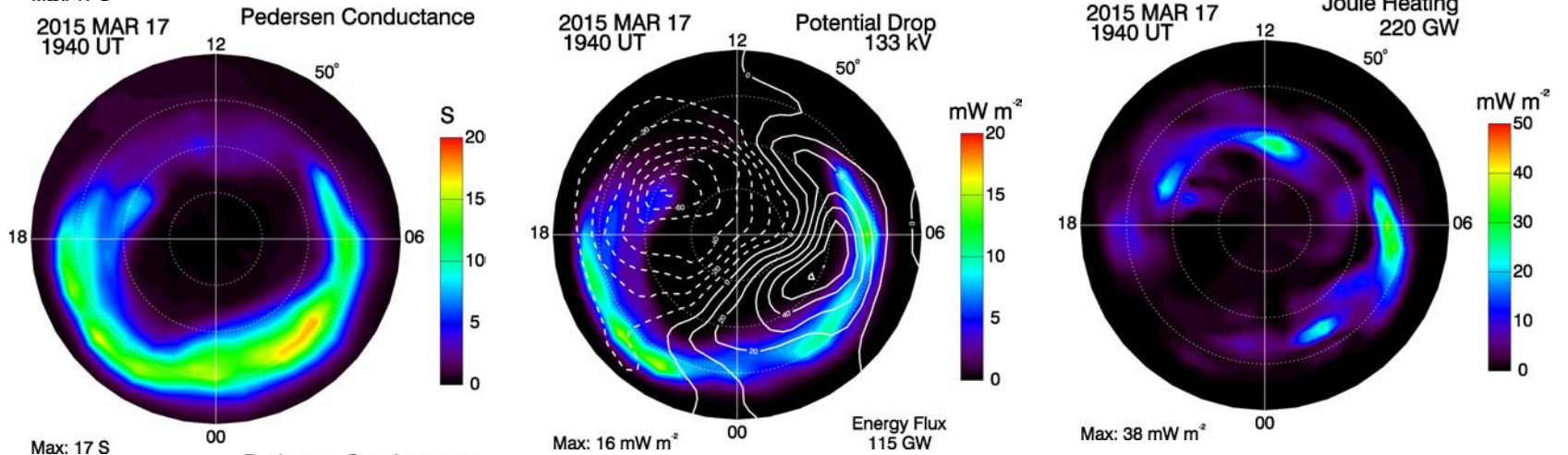




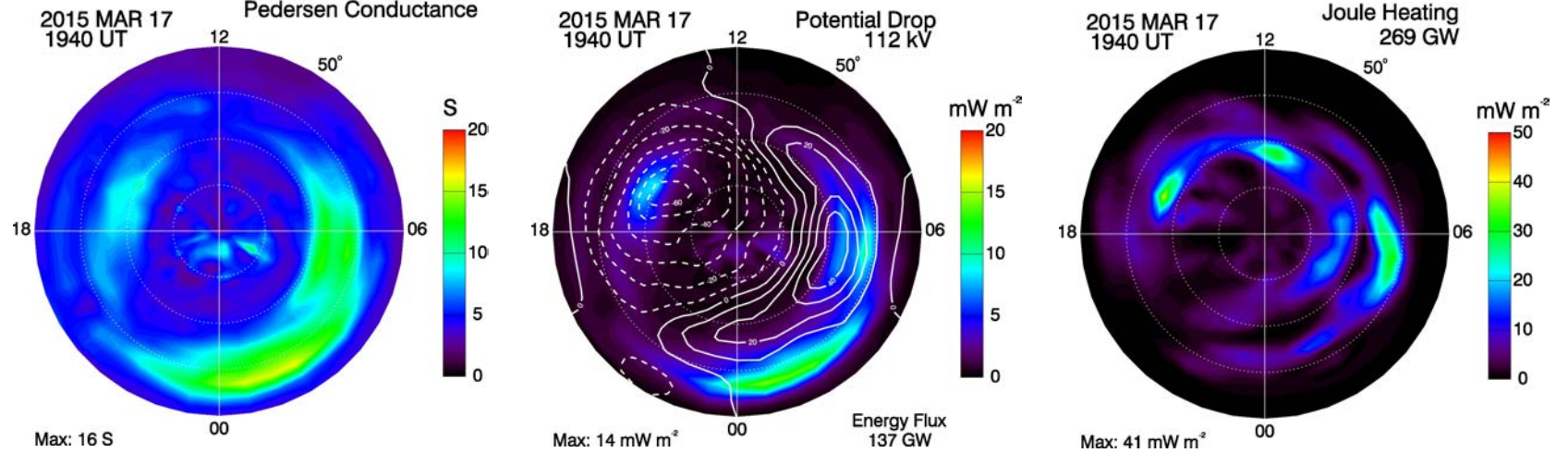
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**SSUSI**

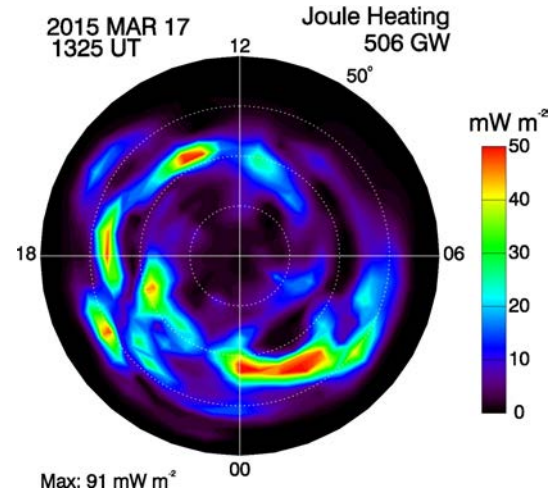
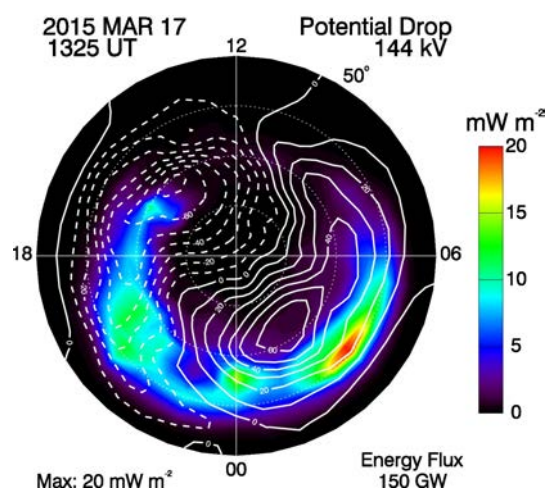
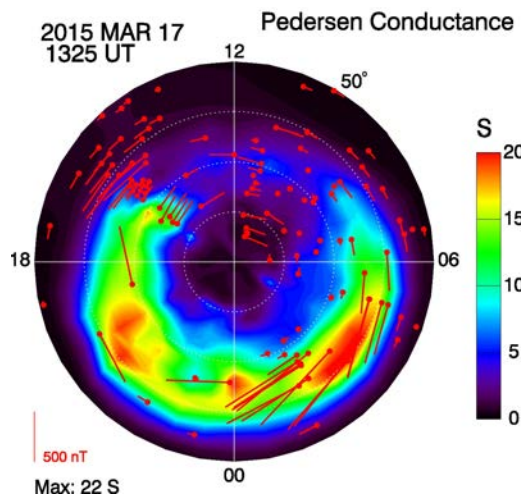


**AMPERE FAC**

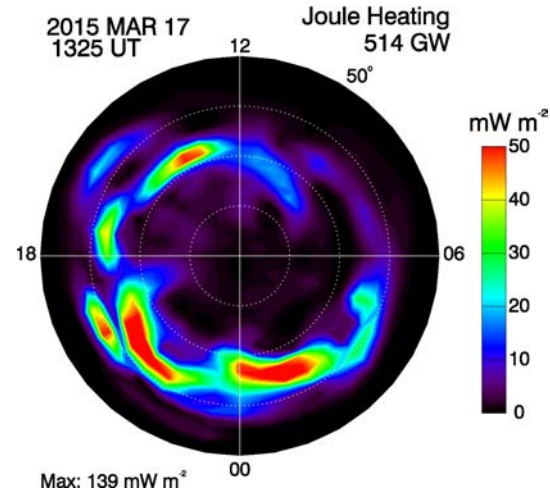
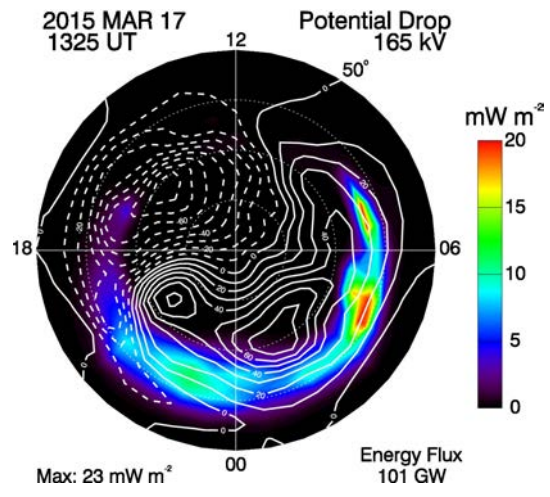
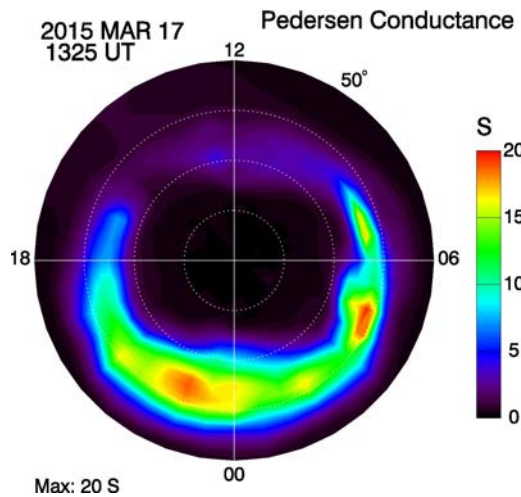




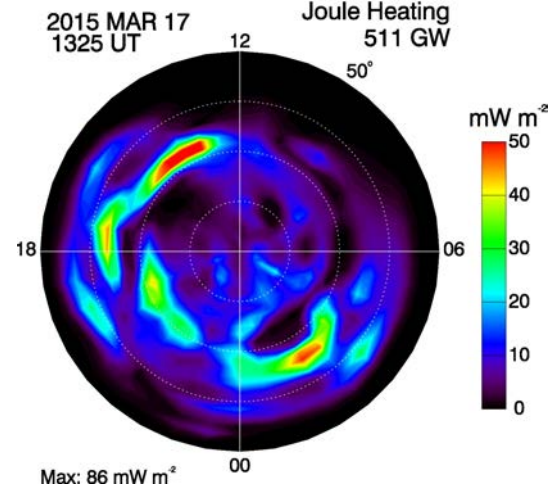
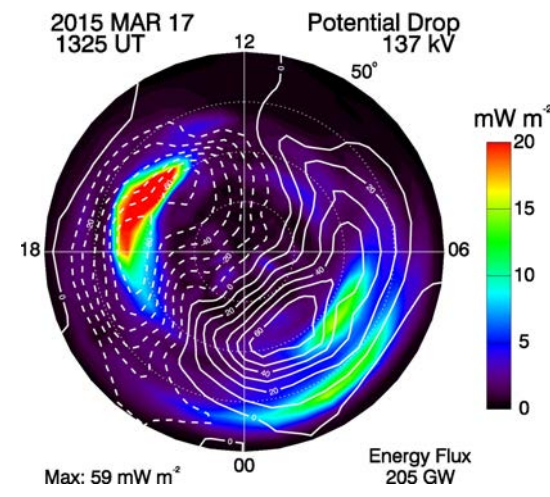
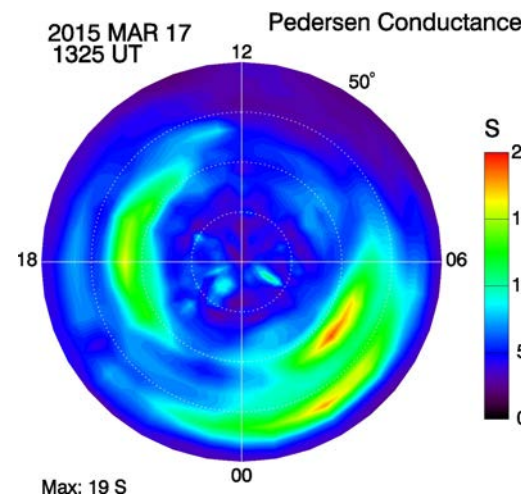
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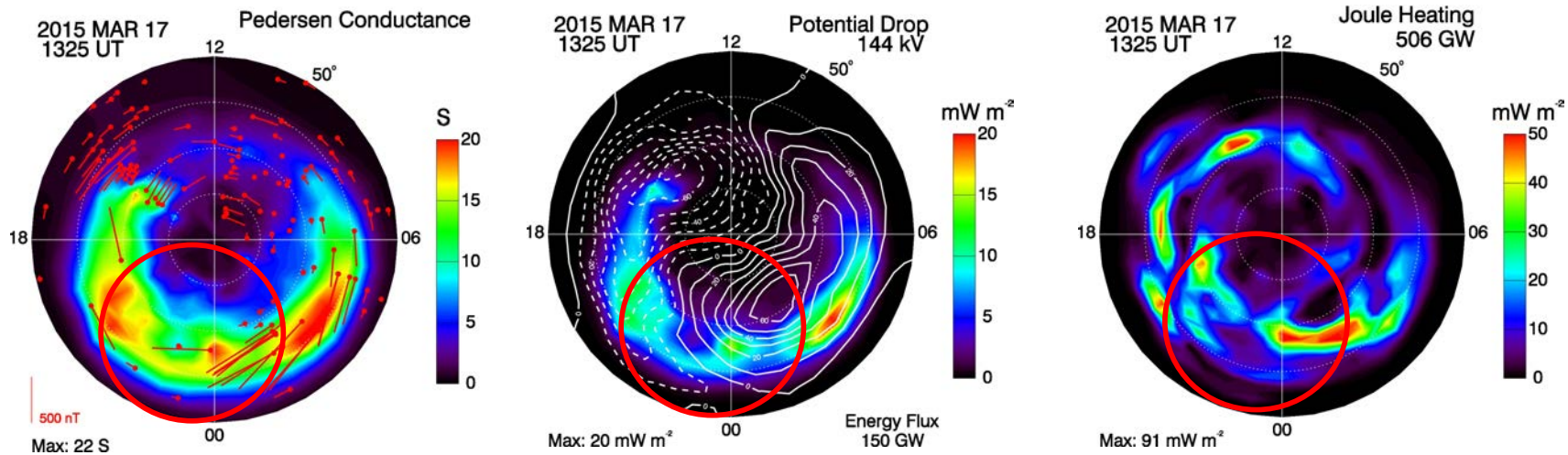


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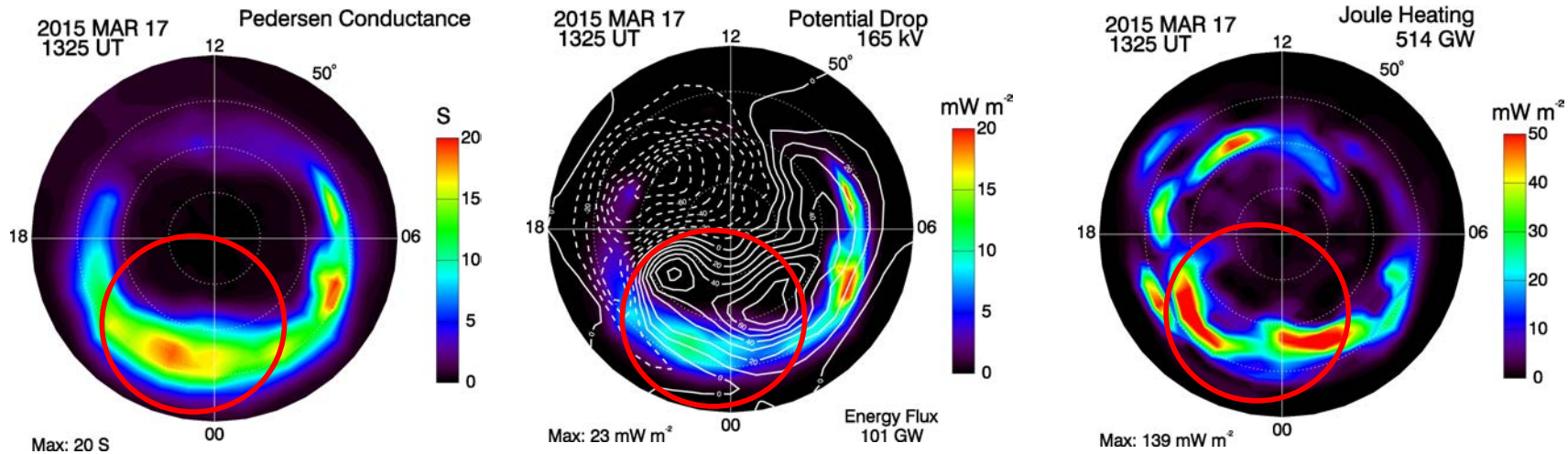




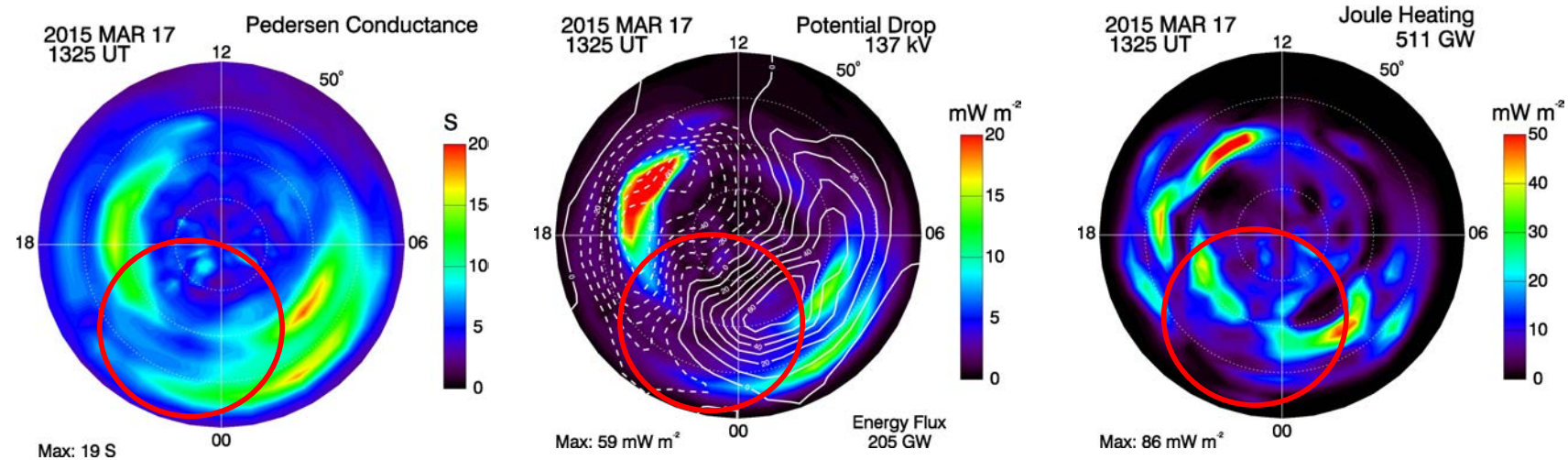
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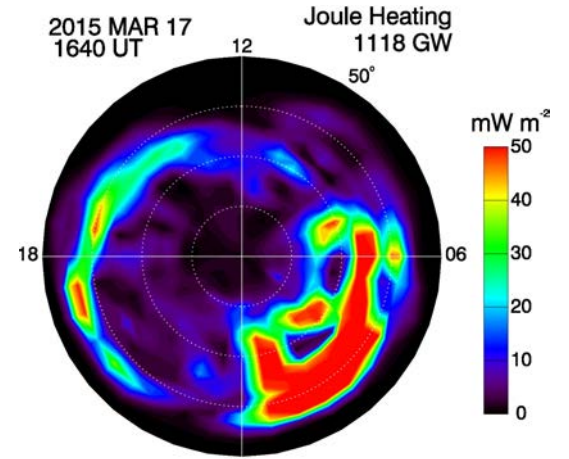
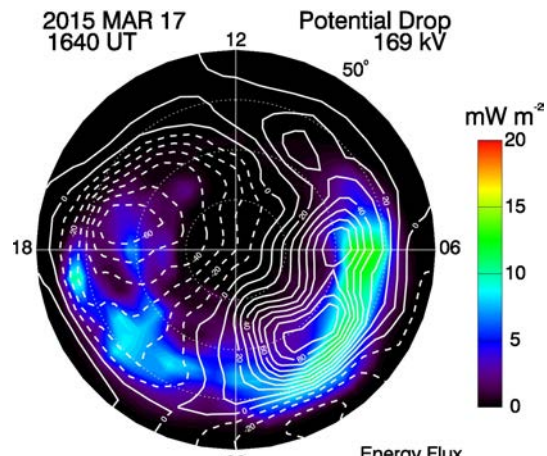
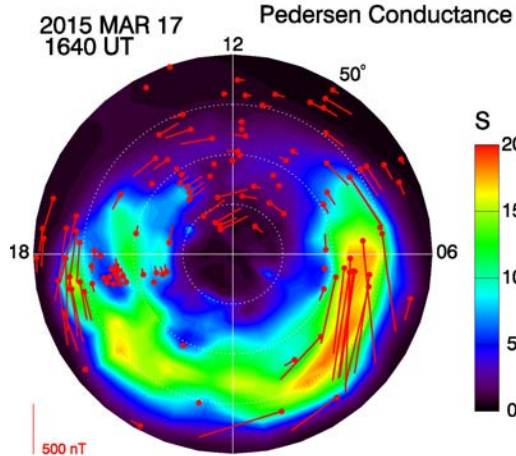


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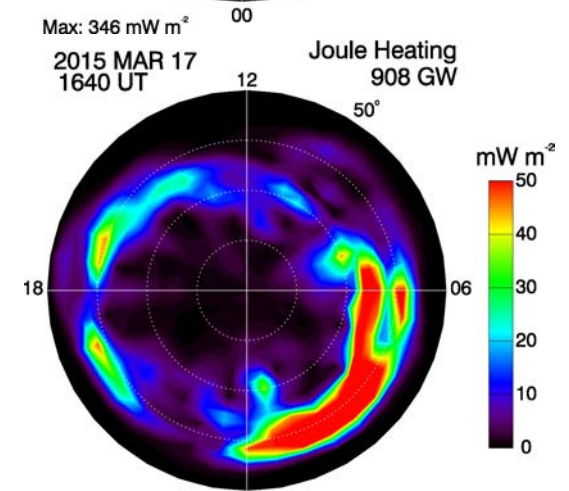
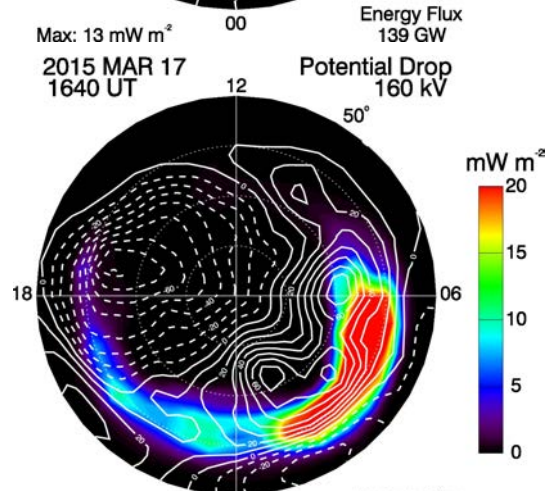
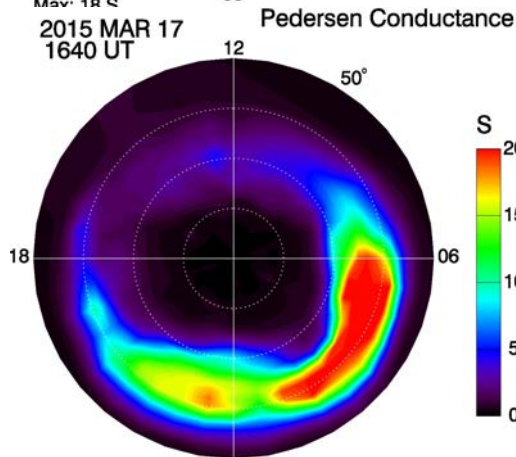




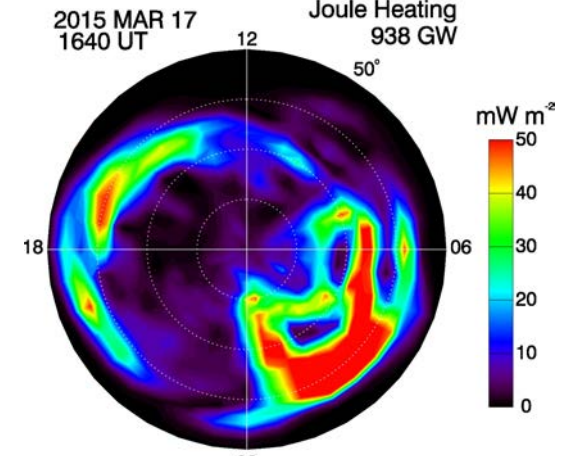
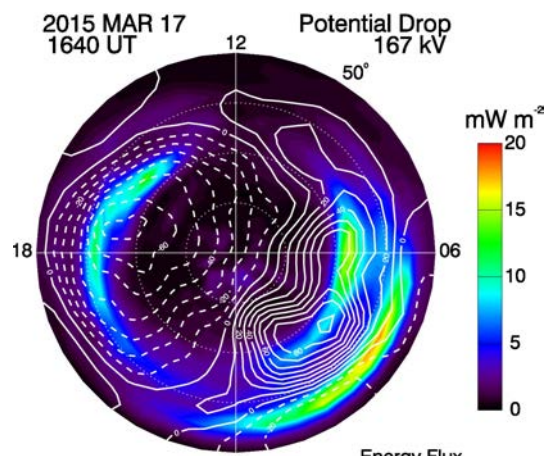
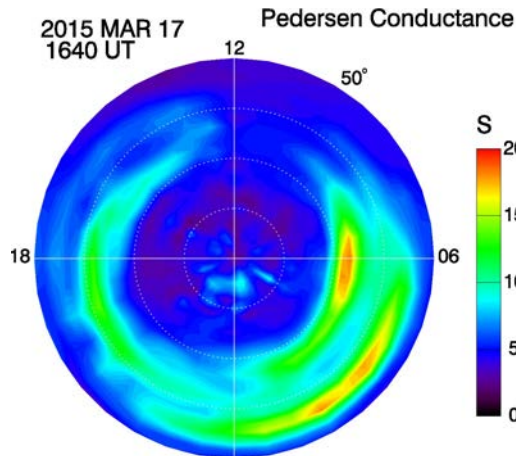
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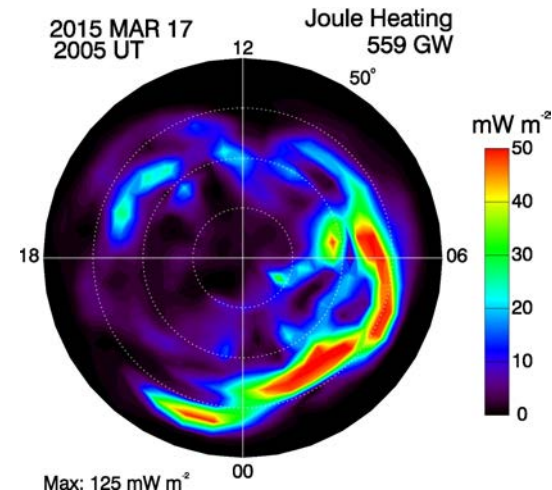
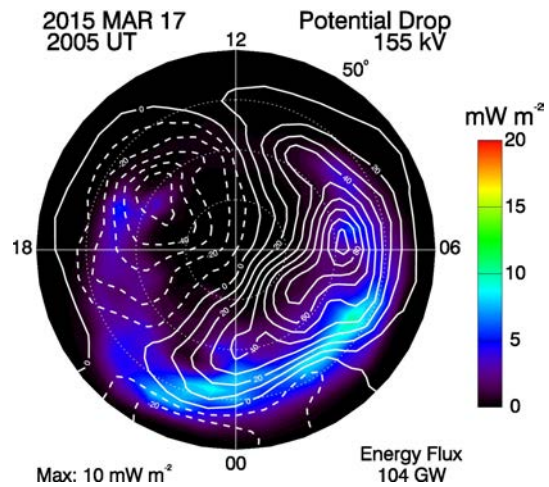
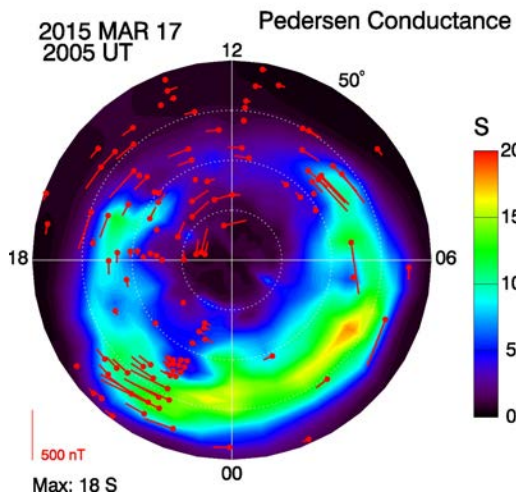


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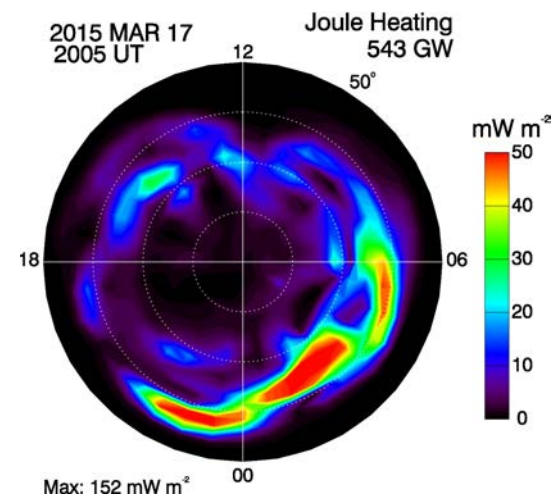
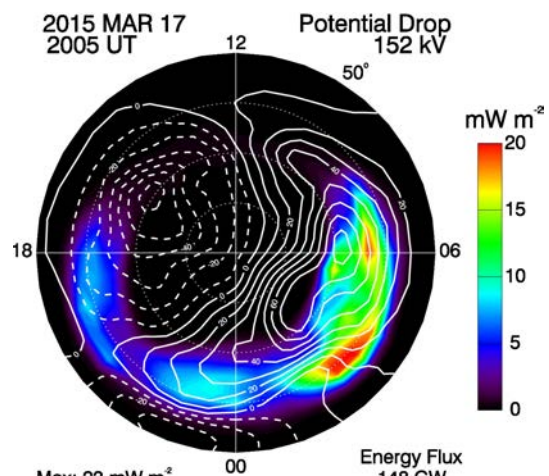
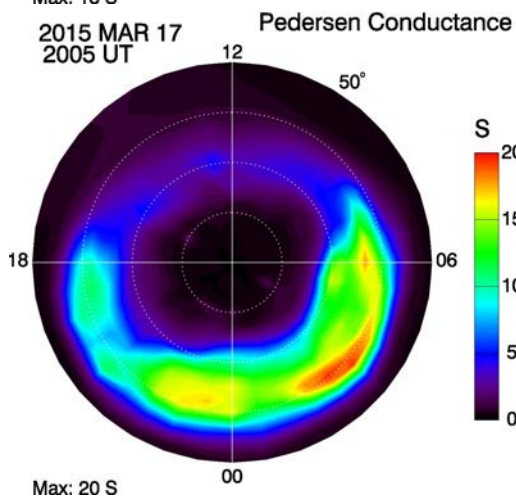




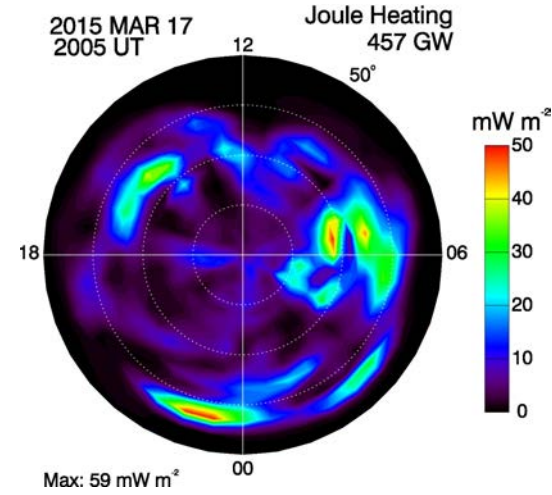
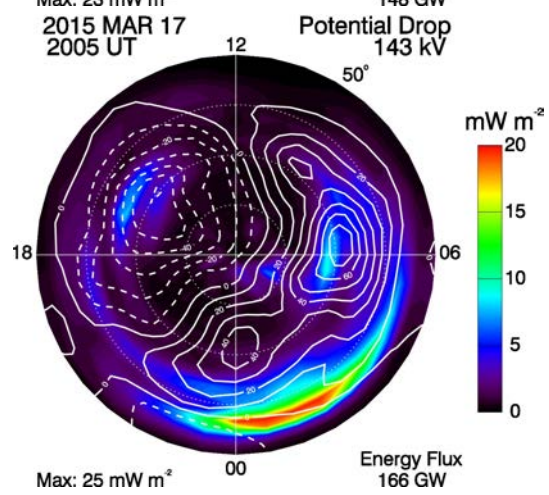
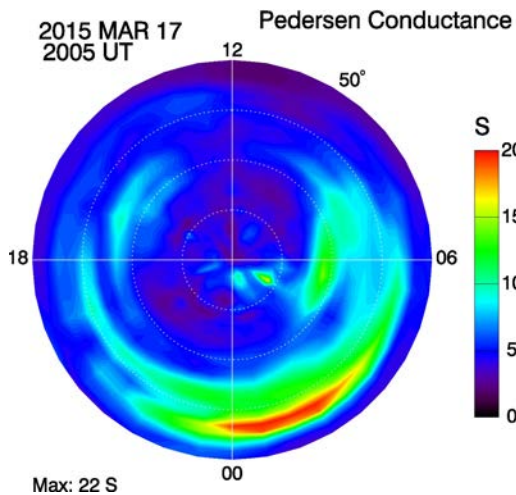
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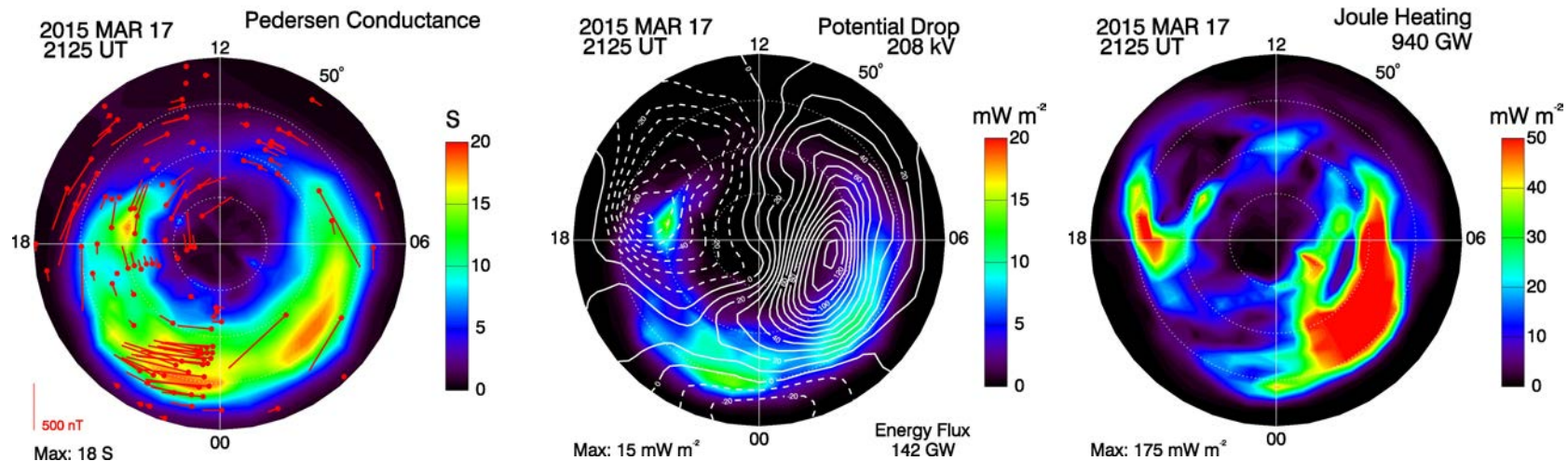


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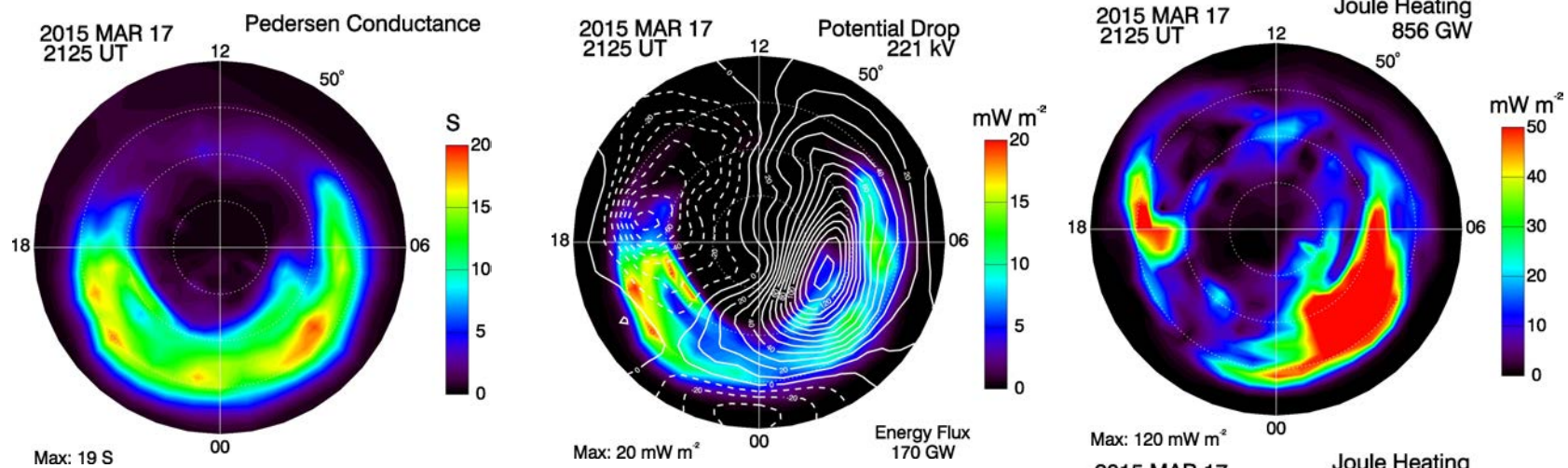




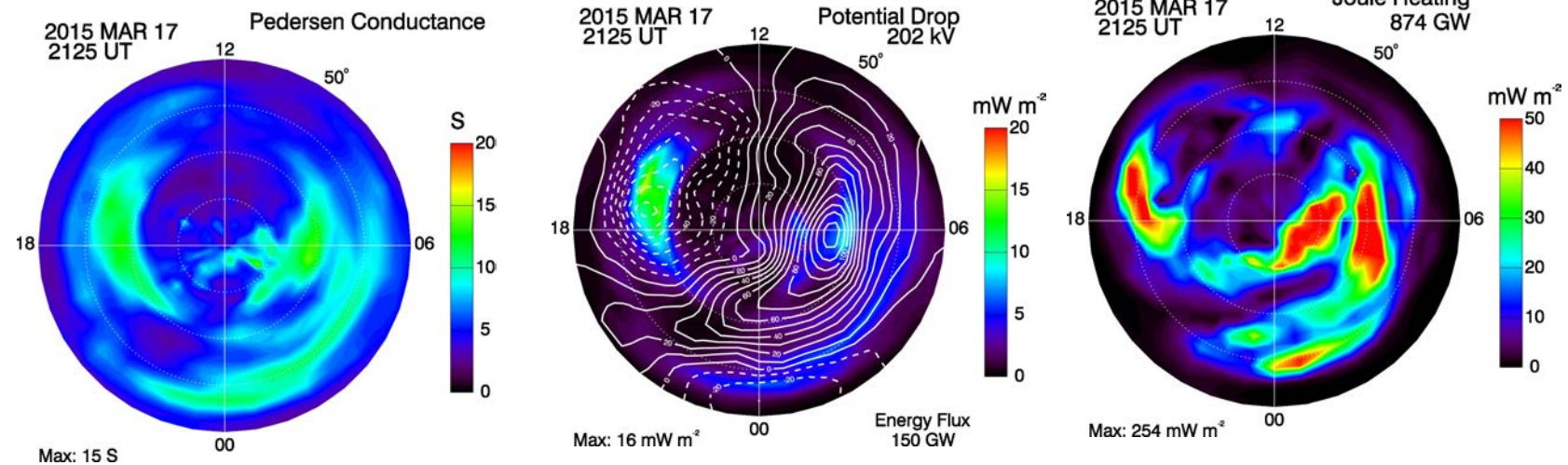
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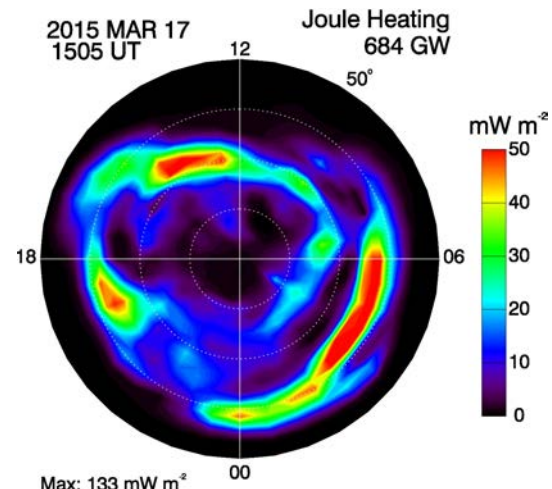
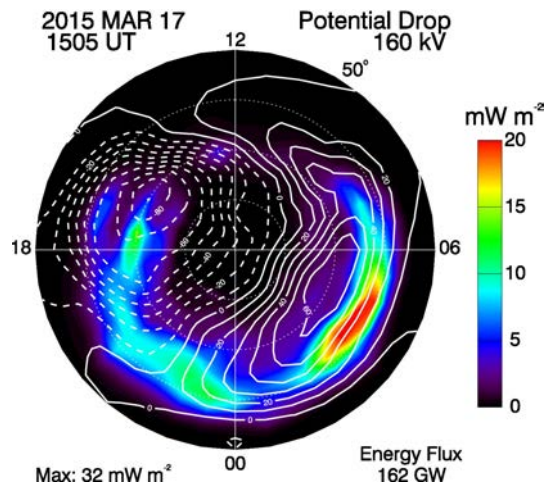
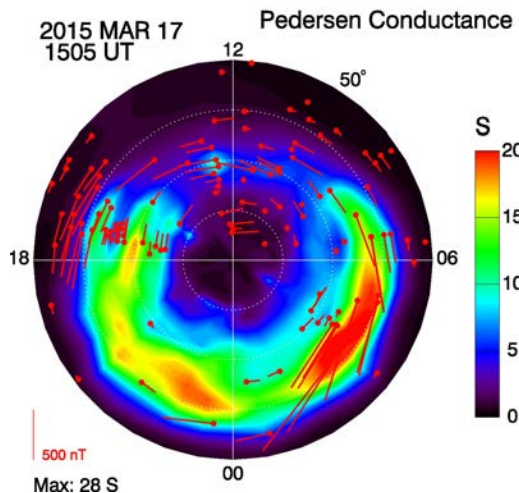


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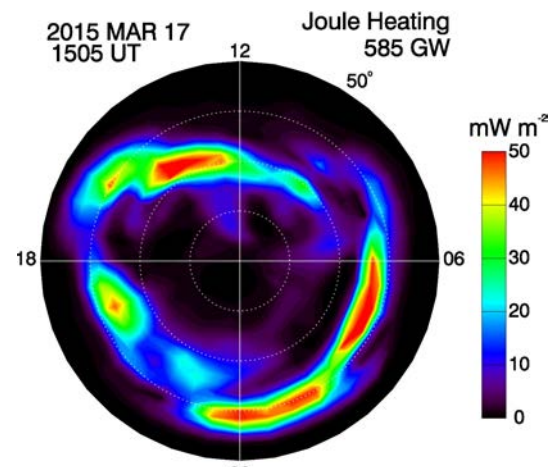
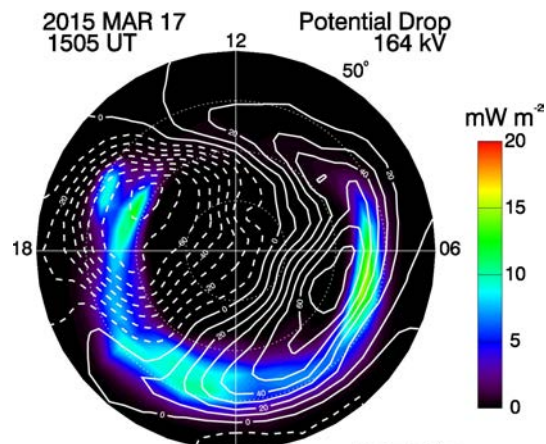
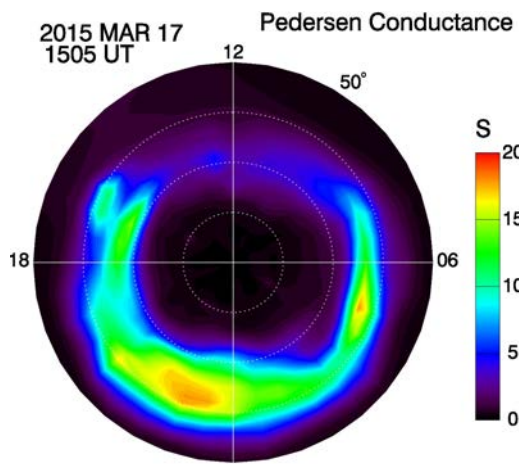




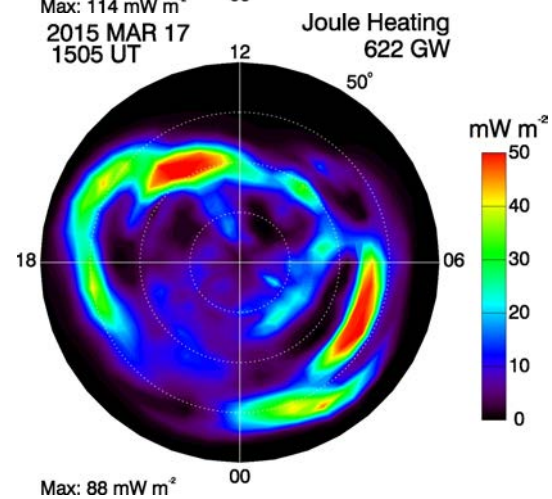
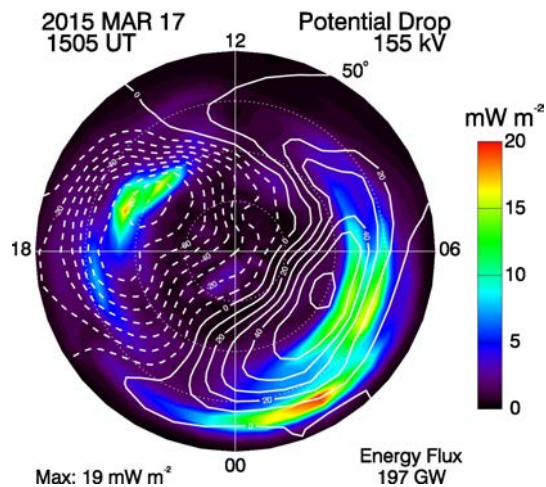
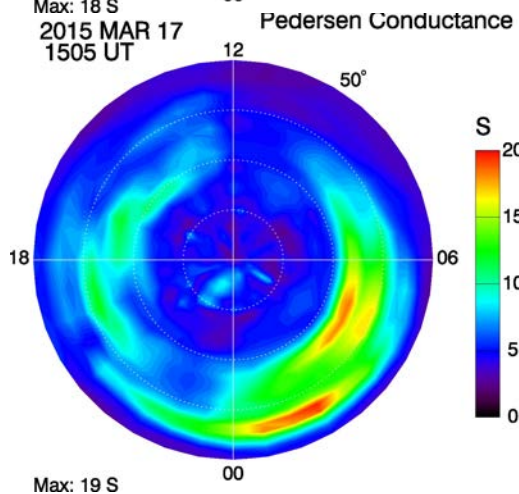
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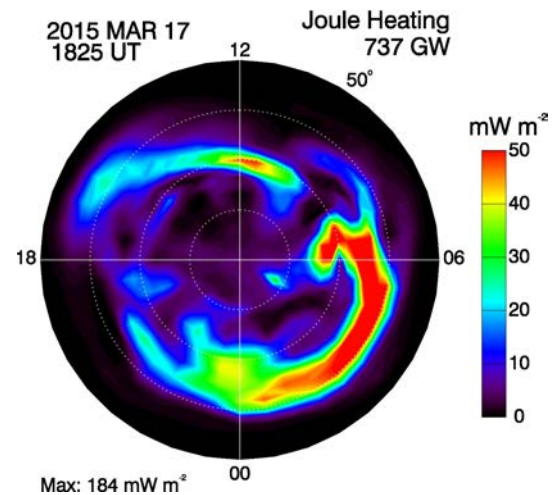
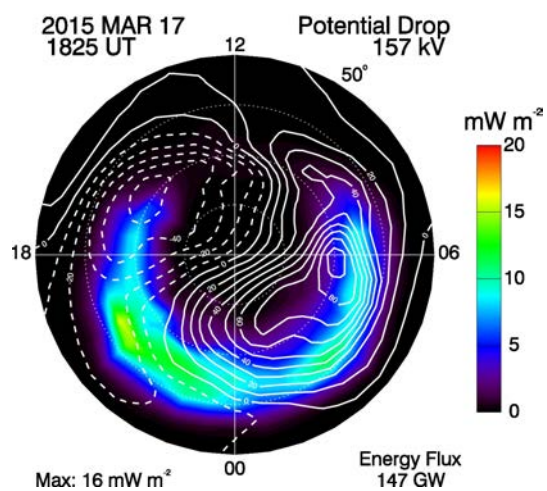
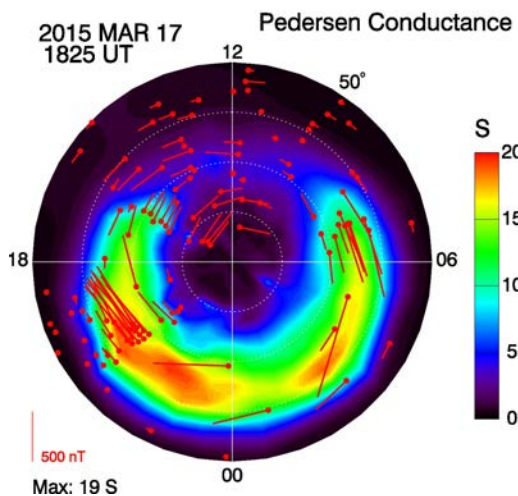


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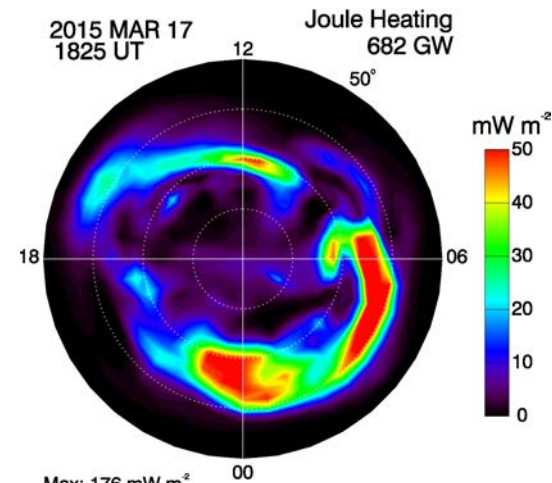
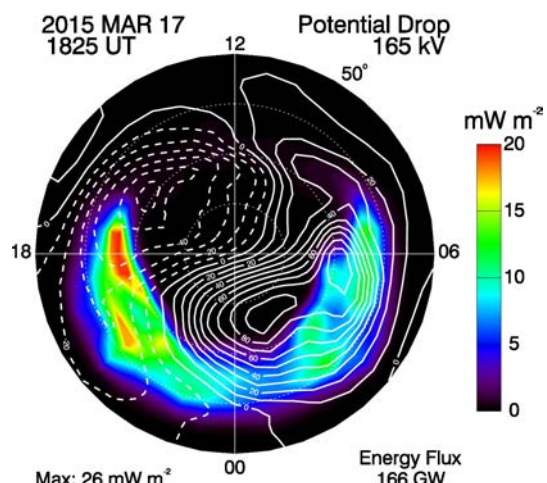
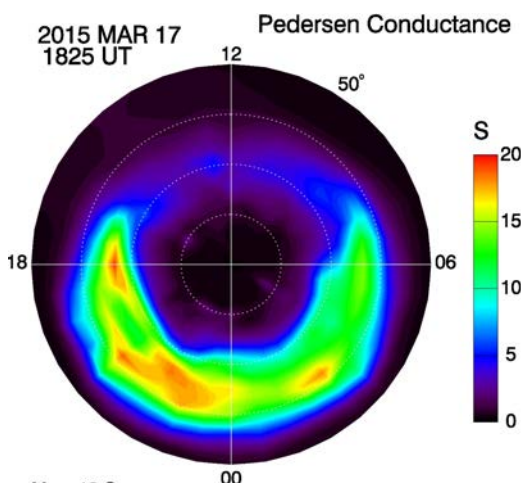




**Magnetometer**



**SSUSI**



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