Relating Global Auroral Images to Plasma Sheet Observations During Auroral Activity

M. O. Fillingim & G. K. Parks
(with special thanks to E. Lee)
Space Sciences Laboratory
University of California, Berkeley

Introduction

Goal:

- Understand the connection of aurora to plasma sheet dynamics
- Not a new idea: *Fairfield et al.* [1999]; *Fillingim et al.* [2000; 2001; 2003]; *Nakamura et al.* [2001; 2002]; and ***many*** others

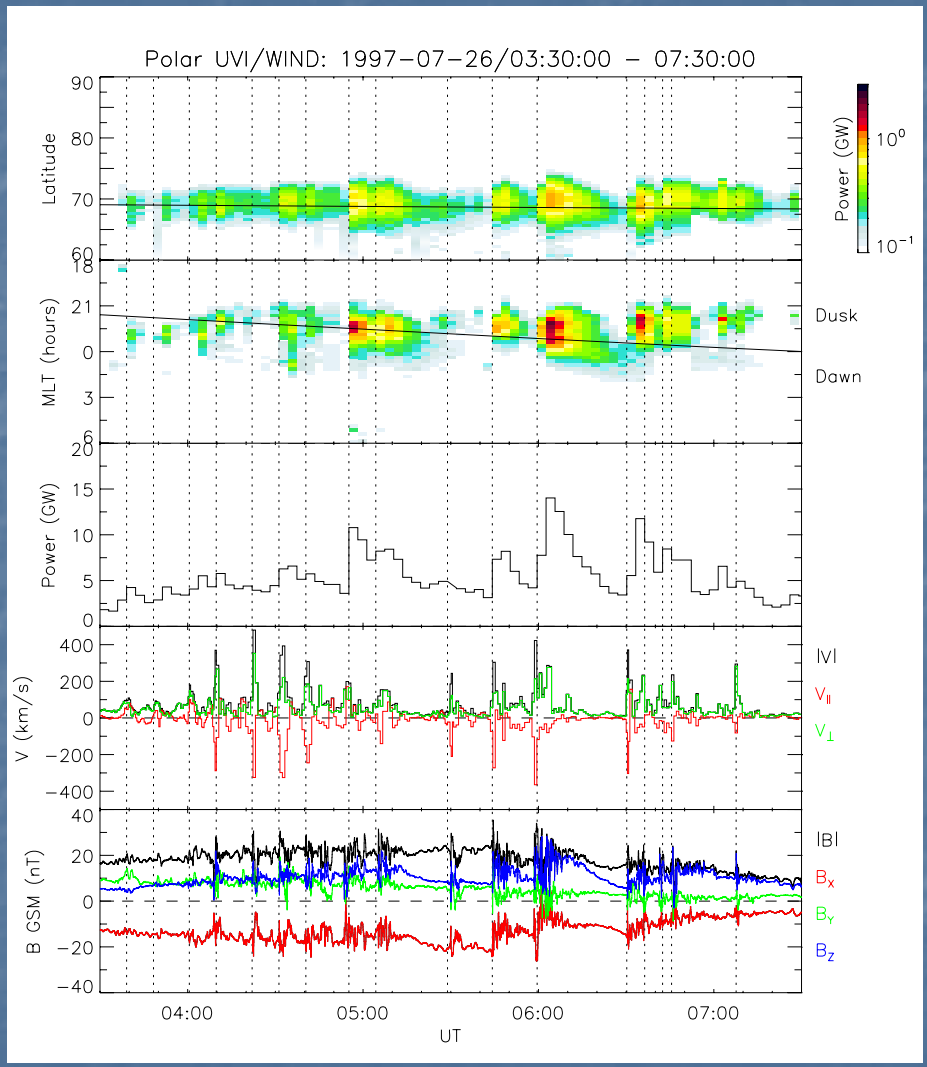
Methodology:

- Correlate global auroral images with in-situ plasma sheet data using IMAGE WIC, Polar UVI, and Cluster
- One illustrative example (same as *Nakamura et al.* [2002])

Conclusions:

- For X Earthward of ~ 20 R_E, plasma sheet activity is magnetically connected to intense auroral emission
- Plasma sheet activity kinetic in nature (not shown)

Introduction



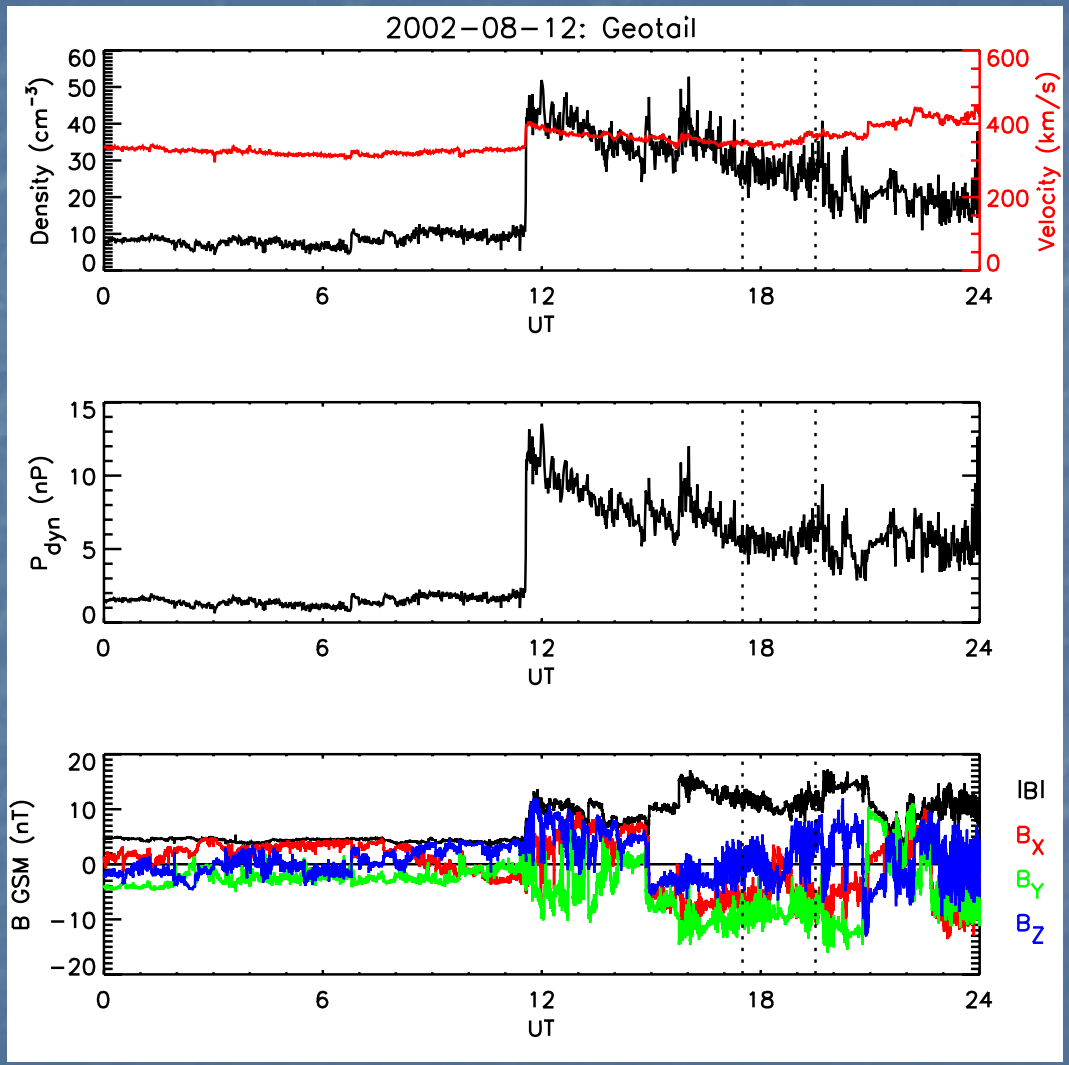
Example: $X_{Wind} \sim -10R_E$ (from *Fillingim et al.* [2000])

Correlation between ΔB, **<v>**, and auroral brightenings ***near Wind footprint***

Simultaneous within resolution of instruments (~ 1min)

Most intense auroral signature ≠ most intense plasma sheet signatures

Solar Wind



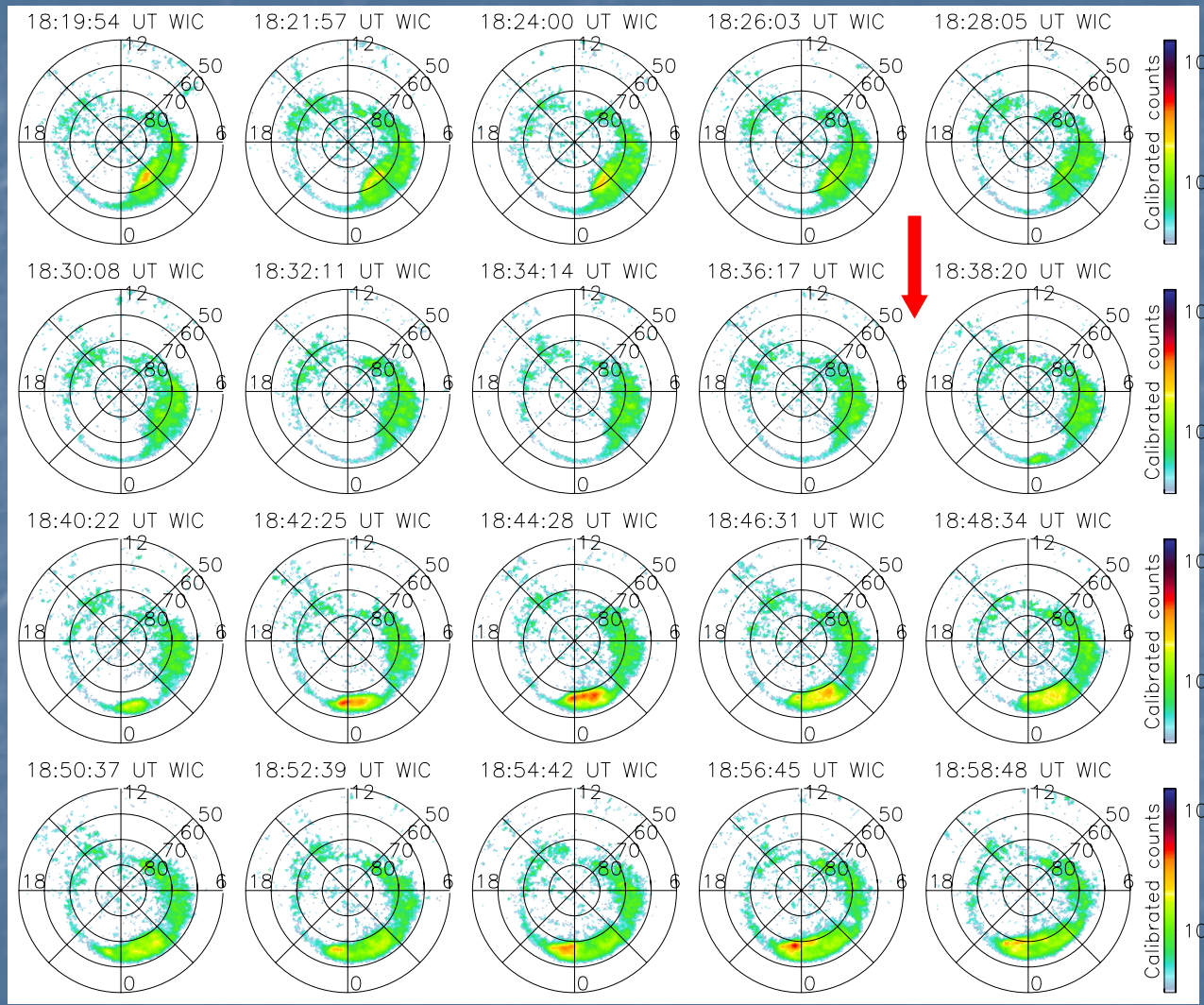
Geotail location:
[20 → 5, 25, 5] R_E GSE

Large pressure pulse observed at 11:30 UT; P_{dyn} increased by 5

Initially $B_Z > 0$; turns southward ~ 15 UT

17:30 – 19:30 UT:
- B_Z variable
- $B_Y < 0$, dominant component

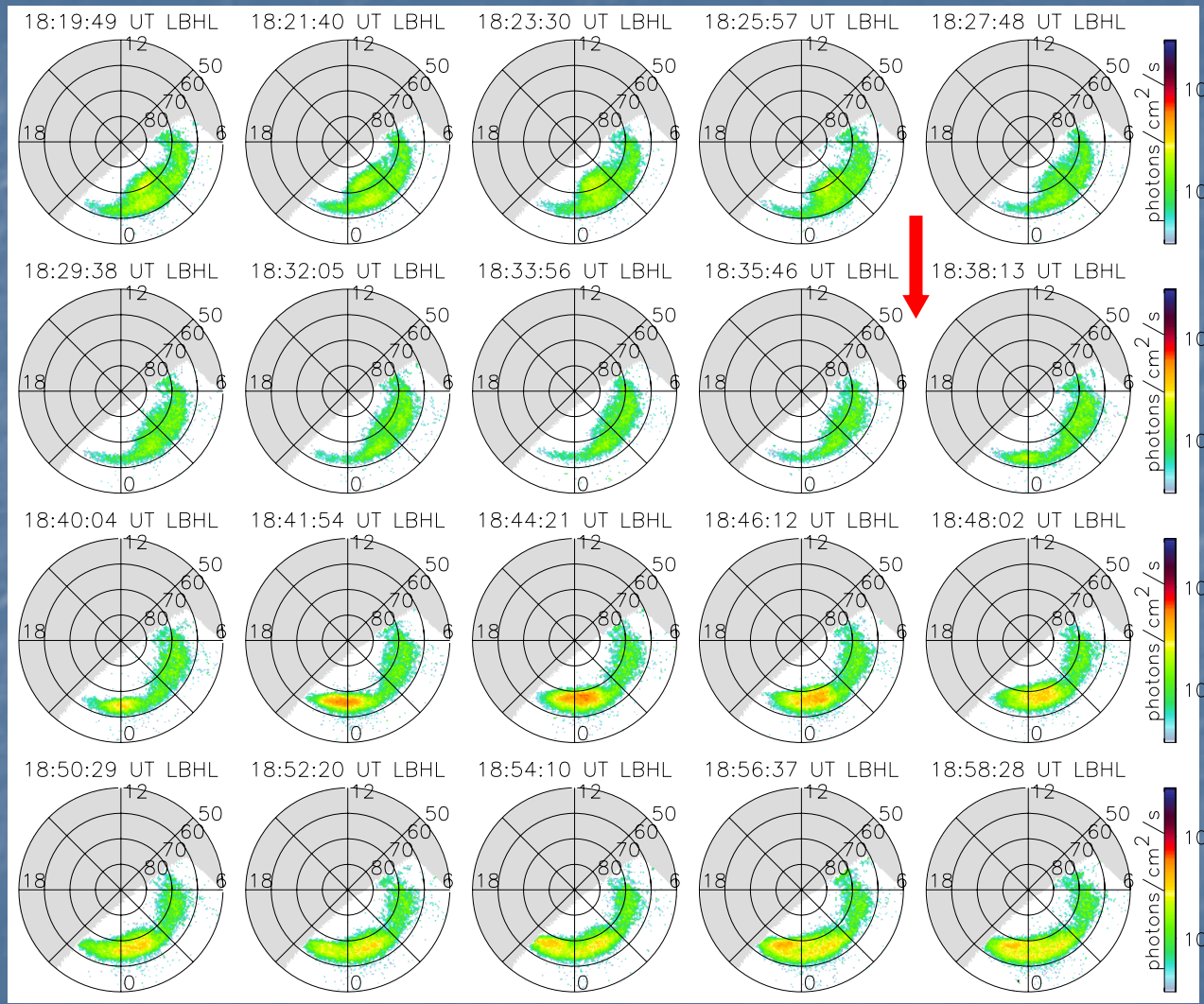
IMAGE FUV



- IP: 10 sec
- Cadence: 2 min
- Filter: WIC (140 – 190 nm)

Onset between 18:36:27 and 18:38:30 UT

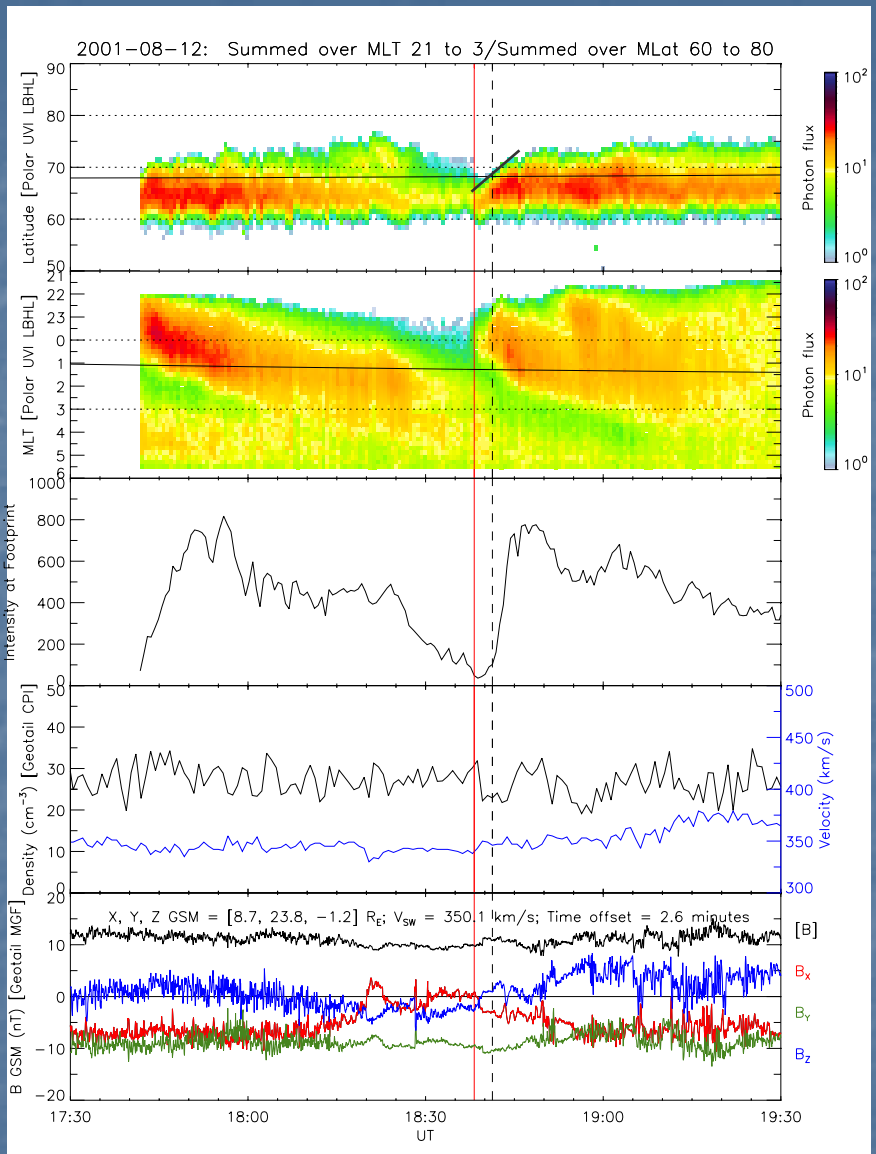
POLAR UVI



Instrument mode
- IP: 37 sec
- Cadence: 37 s (Continuous imaging mode)
- Filter: LBHL (160 – 180 nm)

Only plot every 2nd or 3rd image

Onset between 18:37:37 and 18:38:13 UT



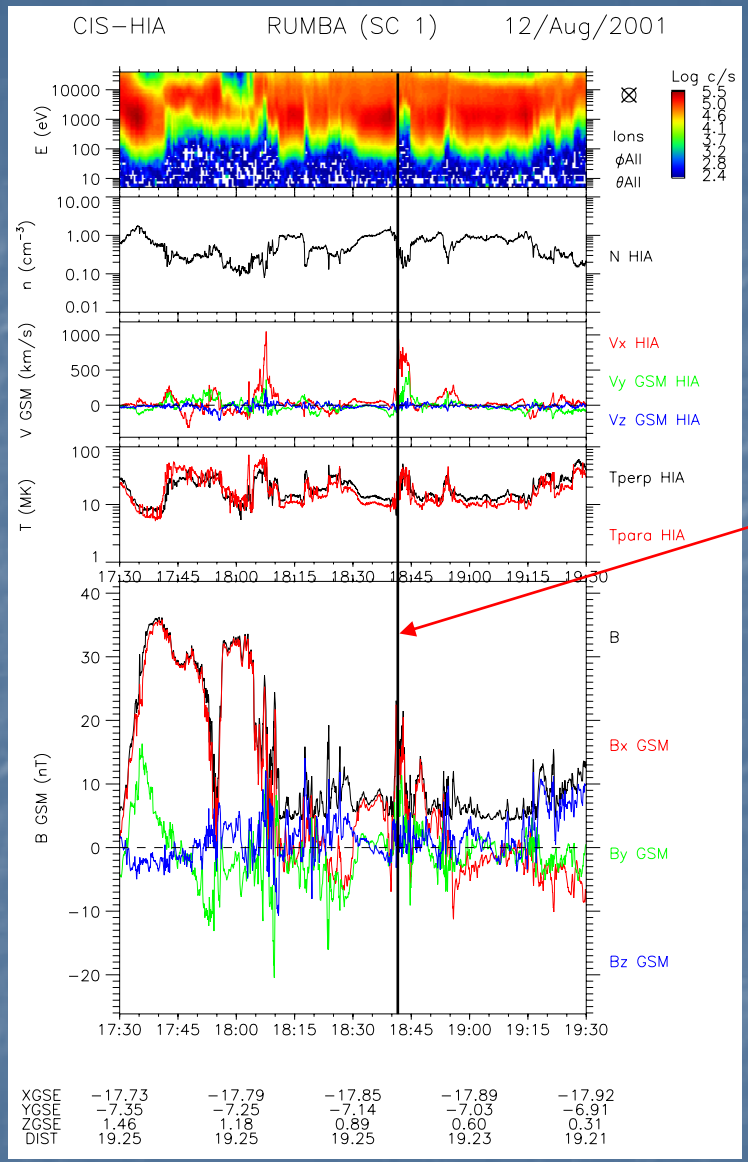
KEOGRAMS

Use every available UVI image

Cluster footprint calculated using T96 also shown

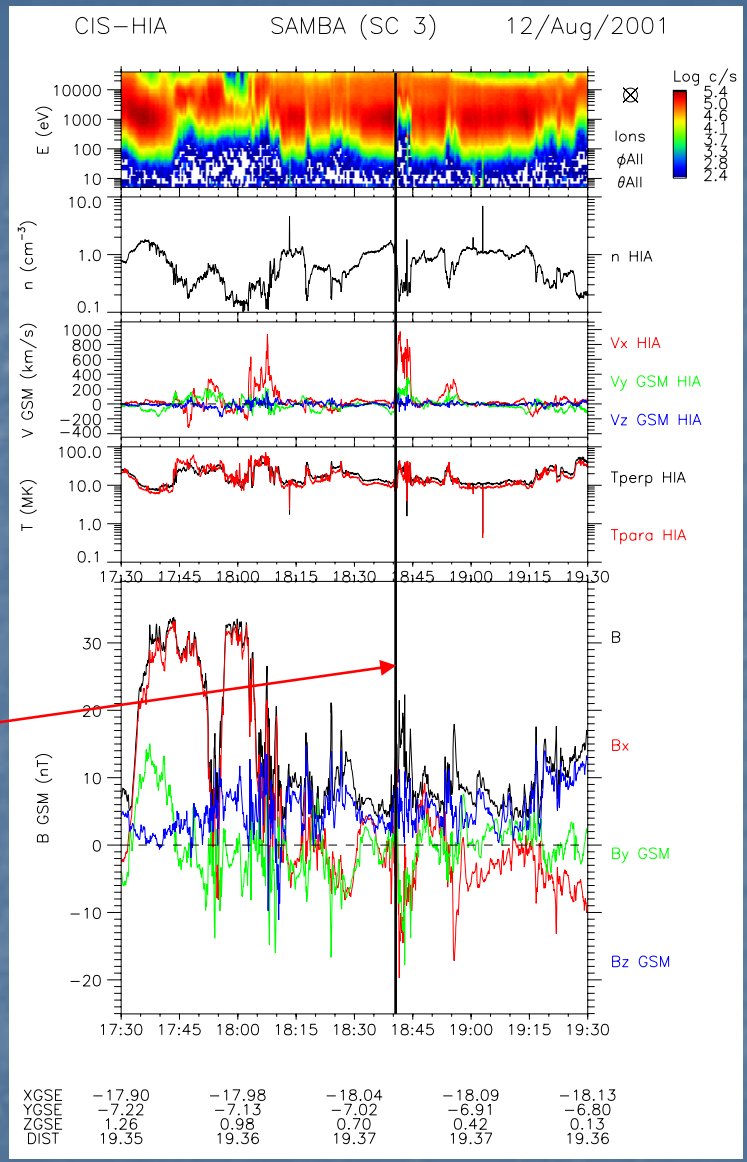
- Onset ~18:38 UT
- From 18:38 – 18:44 UT, poleward expansion 1º/min
  → ~2 km/s in ionosphere
  → > 50 km/s in plasma sheet
- Emission reaches Cluster footprint at ~18:41 UT

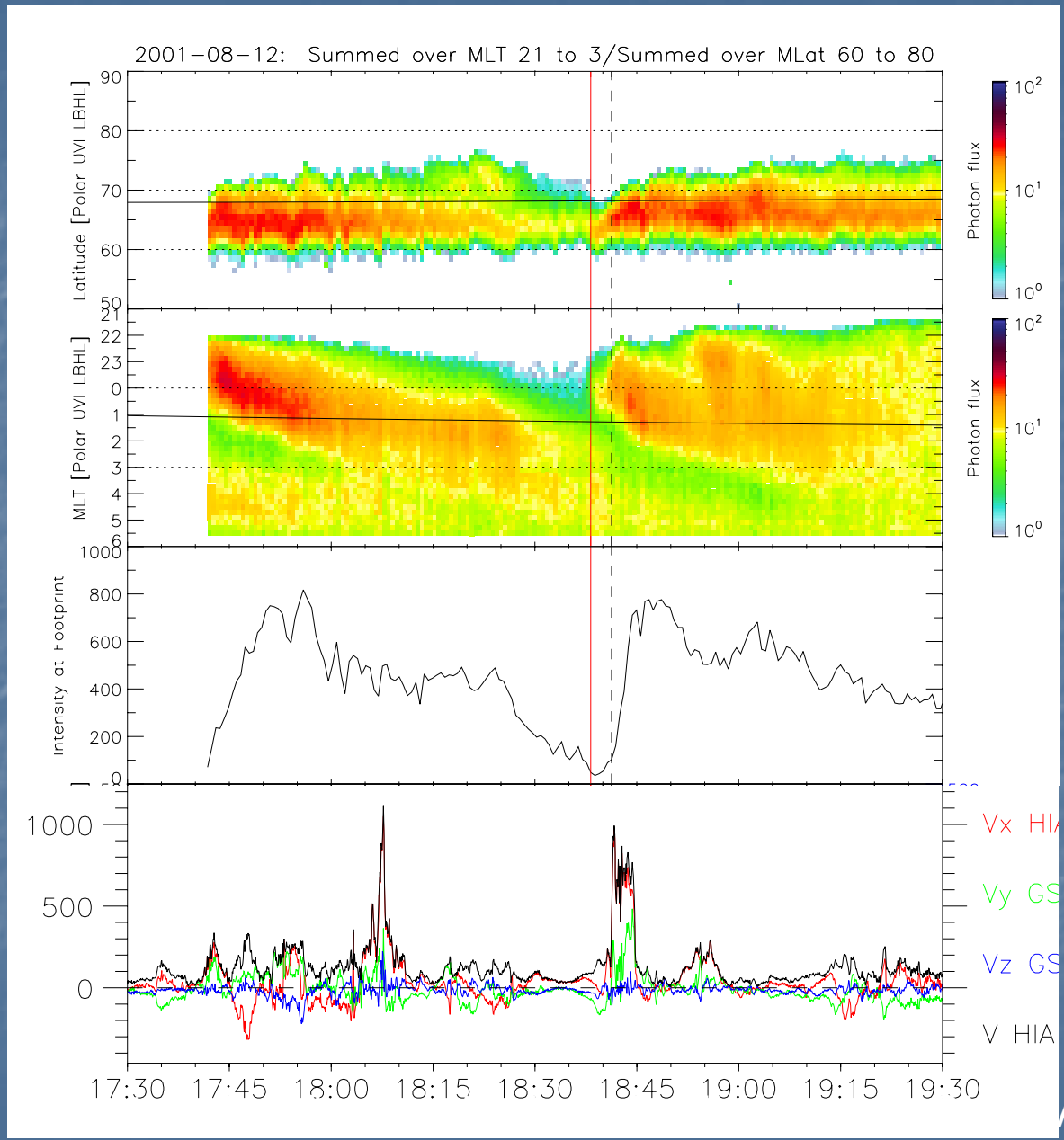
Intensity “near” Cluster footprint



Onset of "activity" n↓, <**v**>↑, T↑, & ΔB at 18 R_E

- SC 1: 18:41 UT
- SC 3: 18:40 UT (SC 3 further equator-ward)



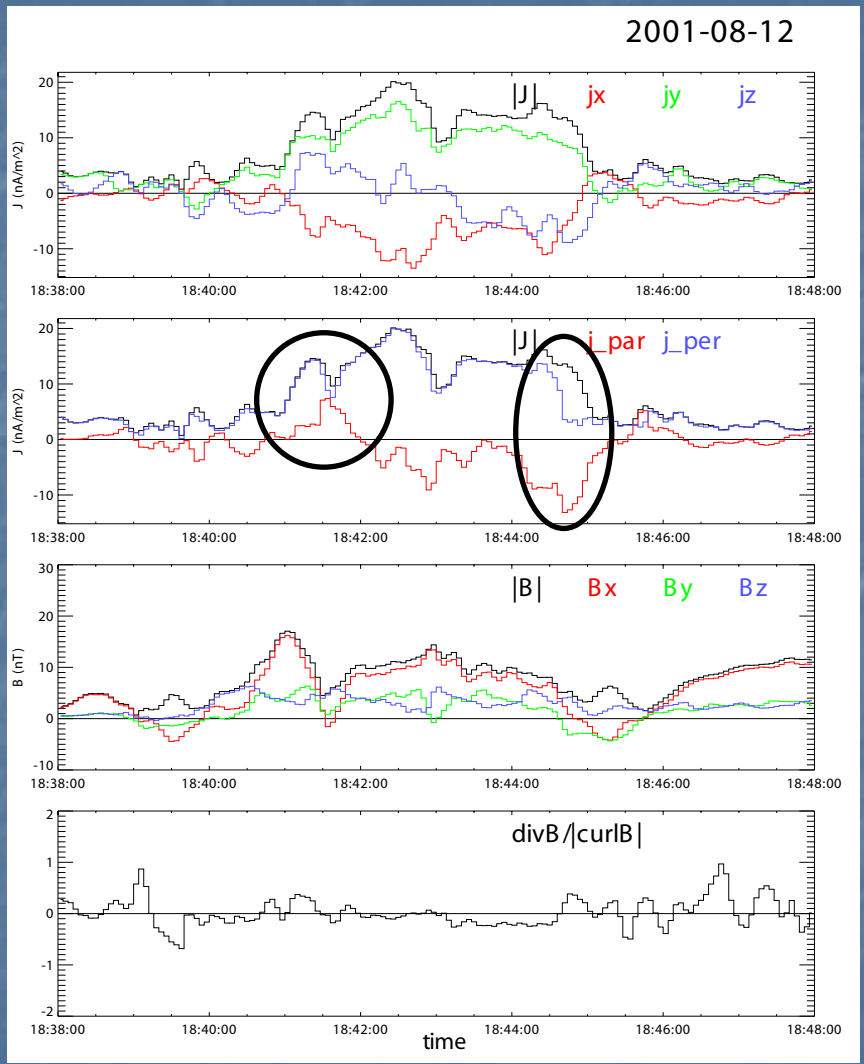


Combine auroral data with plasma sheet <**v**> (could also use n, T, or B)

Auroral intensity at footprint ↔ plasma sheet activty signatures

Better correlation with *changes* in the auroral intensity at footprint (?)

CURRENTS



FAC ➔ Connectivity between plasma sheet and ionosphere

Determine currents using curlometer ($\mathbf{J} = \nabla \times \mathbf{B}$)

Significant FAC during large $\langle \mathbf{v} \rangle$ event near auroral onset

Plasma sheet-ionosphere travel time for thermal electrons ~ 10 seconds
➔ "Simultaneous" within the resolution of the detectors

SUMMARY

Compare global auroral images with in-situ plasma sheet data with the purpose of trying to understand the connection between auroral activity and plasma sheet dynamics

Both UVI and WIC saw substorm onset at ~ 18:38 UT; however, Cluster (X ~ -18 R_E) saw no effects until 18:40 UT (SC 3) and 18:41 UT (SC 1) when auroral emission reached footprints
➔ FACs provide magnetosphere-ionosphere connection

- For X Earthward of ~ 20 R_E, plasma sheet activity (n↓, $\langle \mathbf{v} \rangle$↑, T↑, ΔB, etc.) is magnetically connected to intense auroral emission

- Plasma sheet activity kinetic in nature: $\ell < \rho_i$, $t < 1/\Omega_{ci}$, $\Delta B/B > 1$ (see Chen et al.[2000]; Fillingim et al.[2003]; Parks et al. [2002])

SUMMARY

Compare global auroral images with in-situ plasma sheet data with the purpose of trying to understand the connection between auroral activity and plasma sheet dynamics

Both UVI and WIC saw substorm onset at ~ 18:38 UT; however, Cluster (X ~ -18 R_E) saw no effects until 18:40 UT (SC 3) and 18:41 UT (SC 1) when auroral emission reached footprints
➔ FACs provide magnetosphere-ionosphere connection

- For X Earthward of ~ 20 R_E, plasma sheet activity (n↓, $\langle \mathbf{v} \rangle$↑, T↑, ΔB, etc.) is magnetically connected to intense auroral emission

- Plasma sheet activity kinetic in nature: $\ell < \rho_i$, $t < 1/\Omega_{ci}$, $\Delta B/B > 1$ (see Chen et al.[2000]; Fillingim et al.[2003]; Parks et al. [2002])

SUMMARY

Compare global auroral images with in-situ plasma sheet data with the purpose of trying to understand the connection between auroral activity and plasma sheet dynamics

Both UVI and WIC saw substorm onset at ~ 18:38 UT; however, Cluster (X ~ -18 R_E) saw no effects until 18:40 UT (SC 3) and 18:41 UT (SC 1) when auroral emission reached footprints
➔ FACs provide magnetosphere-ionosphere connection

- For X Earthward of ~ 20 R_E, plasma sheet activity (n↓, $\langle \mathbf{v} \rangle$↑, T↑, ΔB, etc.) is magnetically connected to intense auroral emission

- Plasma sheet activity kinetic in nature: $\ell < \rho_i$, $t < 1/\Omega_{ci}$, $\Delta B/B > 1$ (see Chen et al.[2000]; Fillingim et al.[2003]; Parks et al. [2002])

SUMMARY

Compare global auroral images with in-situ plasma sheet data with the purpose of trying to understand the connection between auroral activity and plasma sheet dynamics

Both UVI and WIC saw substorm onset at ~ 18:38 UT; however, Cluster (X ~ -18 R_E) saw no effects until 18:40 UT (SC 3) and 18:41 UT (SC 1) when auroral emission reached footprints
➔ FACs provide magnetosphere-ionosphere connection

- For X Earthward of ~ 20 R_E, plasma sheet activity (n↓, $\langle \mathbf{v} \rangle$↑, T↑, ΔB, etc.) is magnetically connected to intense auroral emission

- Plasma sheet activity kinetic in nature: $\ell < \rho_i$, $t < 1/\Omega_{ci}$, $\Delta B/B > 1$ (see Chen et al.[2000]; Fillingim et al.[2003]; Parks et al. [2002])