Conjugate Observations of Substorm Recovery Time Scales from Two Global Auroral Imagers: Inter-calibration and Initial Results

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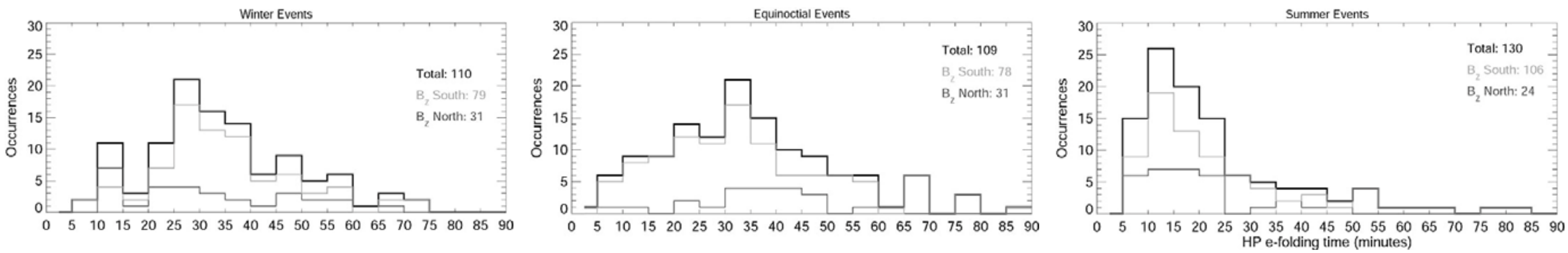
Outline

1. Motivation and Previous Work
   - Discrepancy between substorm recovery time scales determined by *Chua et al.* [2004] and *Fillingim et al.* [2007] using ***different instruments*** (Polar UVI vs IMAGE FUV)
   - Is discrepancy due to an instrument effect?
2. Inter-calibration and Initial Results
   - Simultaneous “same-scene” substorm observations
   - Simultaneous, conjugate substorm observations
3. Summary and Conclusions
   - Challenges using multiple data sets/instruments
   - How to address them

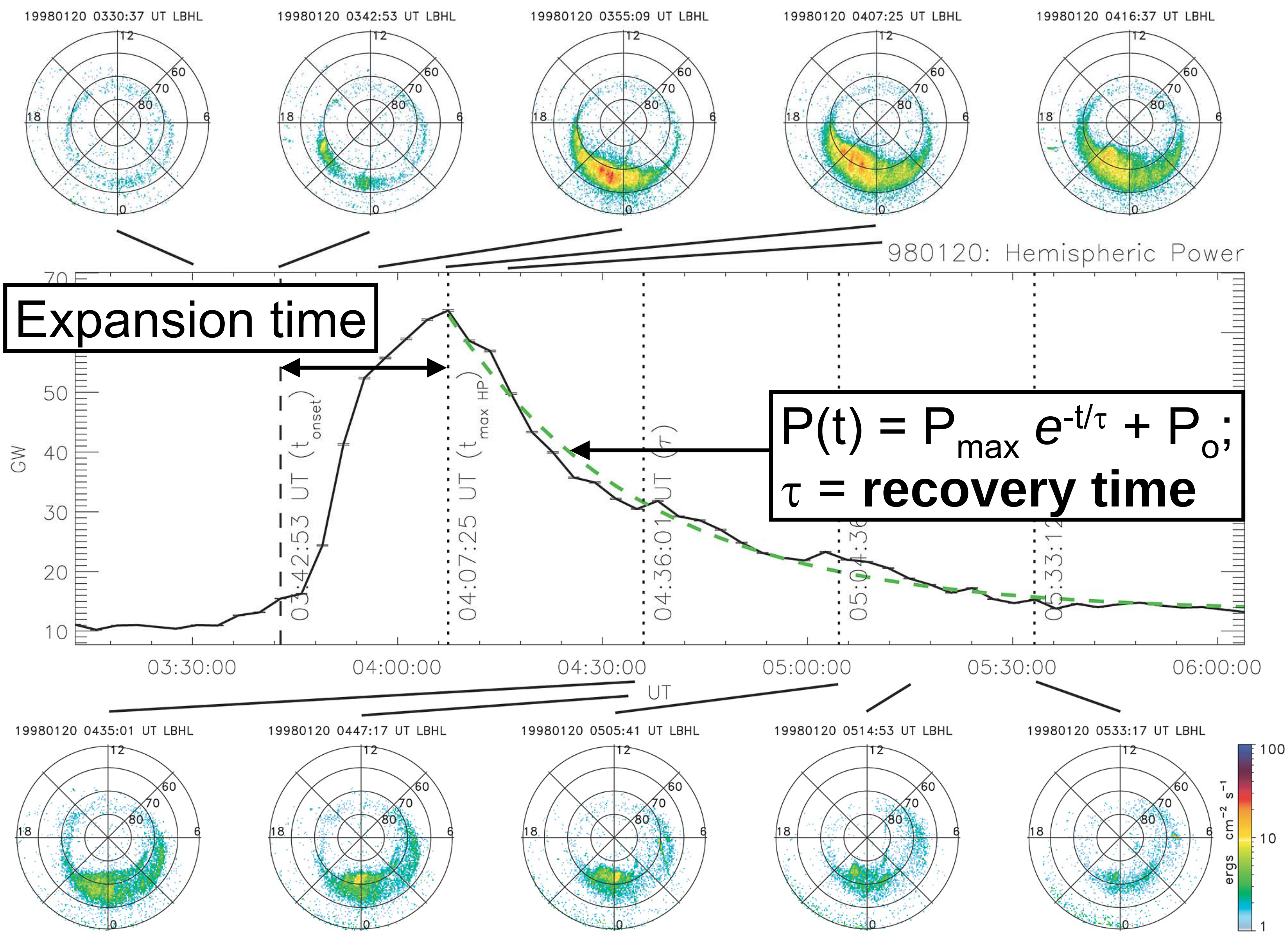
Previous Work 1

Chua et al. [2004] analyzed 350 substorms



Recovery time scale ~ 2X longer during winter than during summer (32 minutes vs. 18 minutes)
➔ Substorms last longer in darkness than in sunlight

Implications for auroral conjugacy (esp. during solstice):
- More energy deposited in dark hemisphere
- Asymmetric energy input during auroral substorms
  ➔ Drives asymmetric upper atmospheric dynamics



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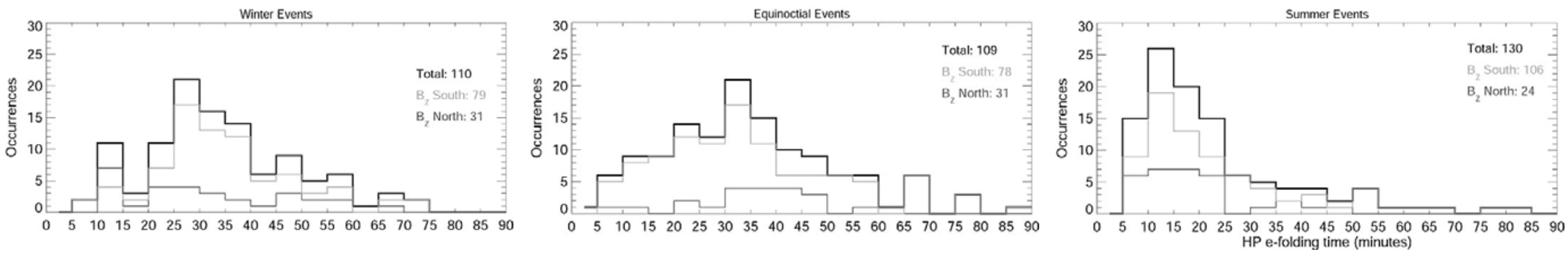

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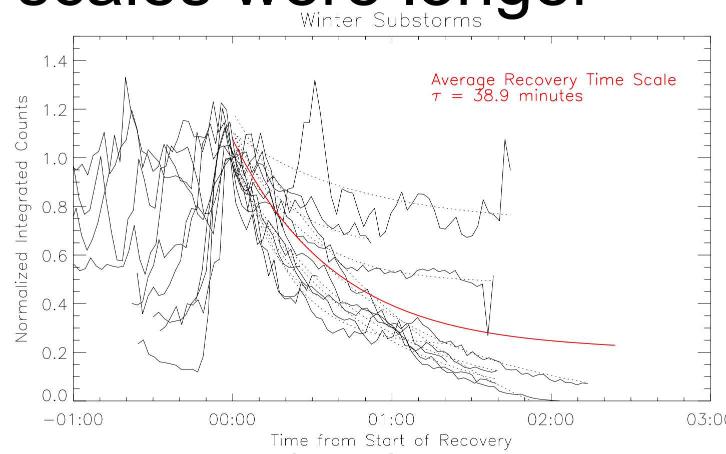
Previous Work 2

Fillingim et al. [2007] extended this using IMAGE FUV

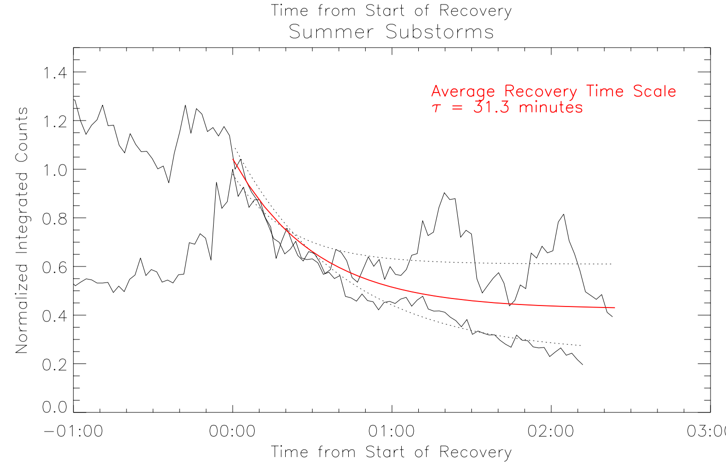
- Median substorm recovery time scales were longer
  46 min vs. 32 min (winter)
  41 min vs. 19 min (summer)

- No sig. seasonal variation
  46 min vs. 41 min (~ 10% diff)



Caveats:

- Very small sample size:
  10 vs. 350 substorms
- Differences in instrument
  filter responses ← **check this!**



Instrumentation

IMAGE Far UltraViolet (FUV)
- Wideband Imaging Camera (WIC)

Polar UltraViolet Imager (UVI)
- LBH Short (LBHS) & Long (LBHL) filters

Minor temporal and spatial differences

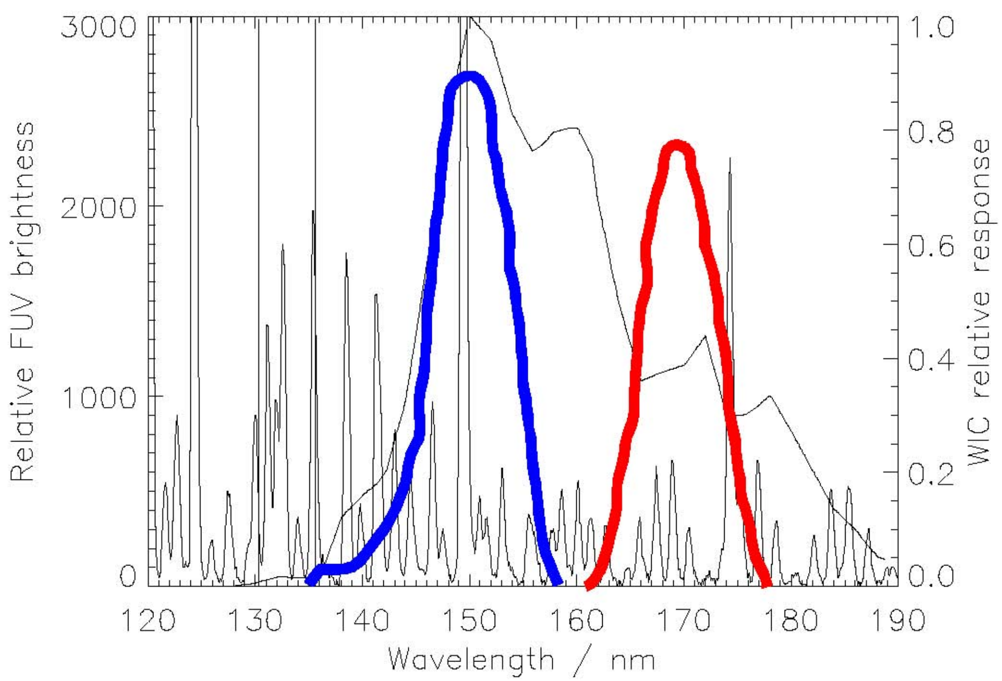
Spectral Resolution

WIC: 140 to 190 nm

LBHS: 140 to 160 nm

LBHL: 160 to 180 nm

Respond to different energies (due to O_2)



Methodology

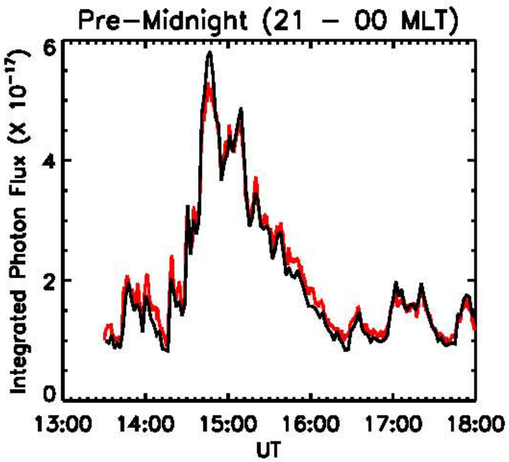
- Identify substorms when IMAGE FUV and Polar UVI are both viewing the same (northern) hemisphere
- Start in December 2000 → optimal orbit & no dayglow
- *Chua et al.* [2004] computed auroral power from LBHL – WIC and LBHS don't (directly) measure energy flux
- Compute area-integrated photon flux (photons/sec) in several local time sectors (show premidnight sector)
- To plot on same scale, adjust WIC integrated flux

  (WIC – offset)/35 ≈ LBHL

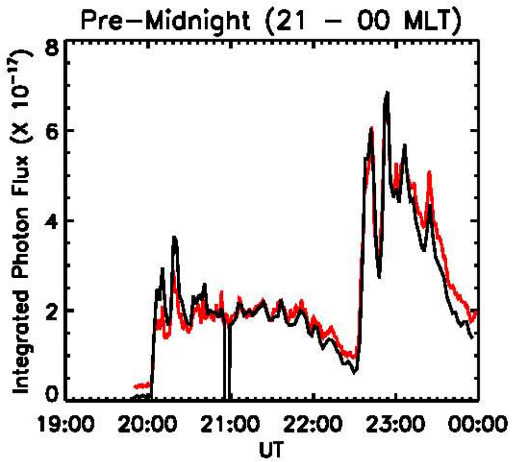
  where offset depends on width of local time sector
- Are slopes of WIC and UVI observations the same?

Results: WIC & LBHL

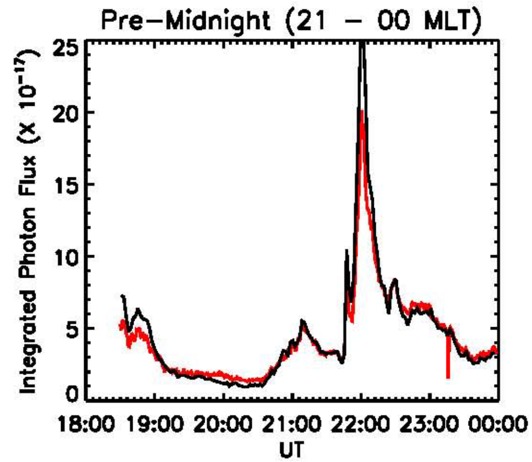
2000–12–02



2000–12–04



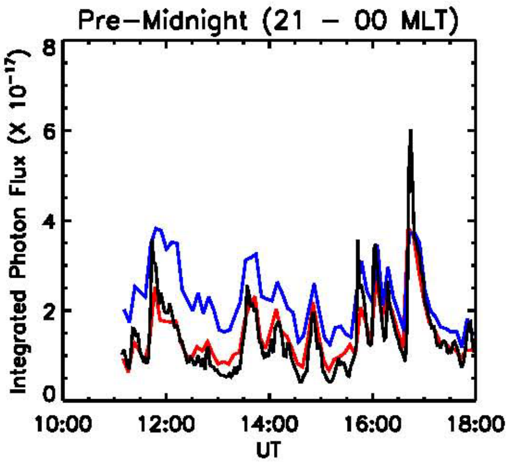
2000–12–07



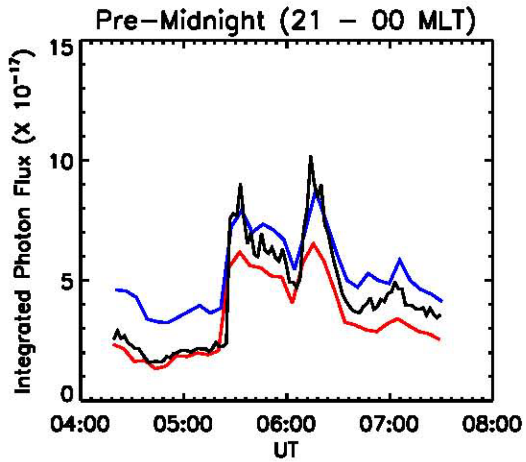
- Magnitude of adjusted WIC and LBHL integrated photon fluxes are approximately equal
  - WIC often observes slightly larger peak magnitudes
- Slopes of WIC and LBHL integrated photon fluxes during recovery phase are also approximately equal! ✓

Results: WIC, LBHS, & LBHL

2000–12–05



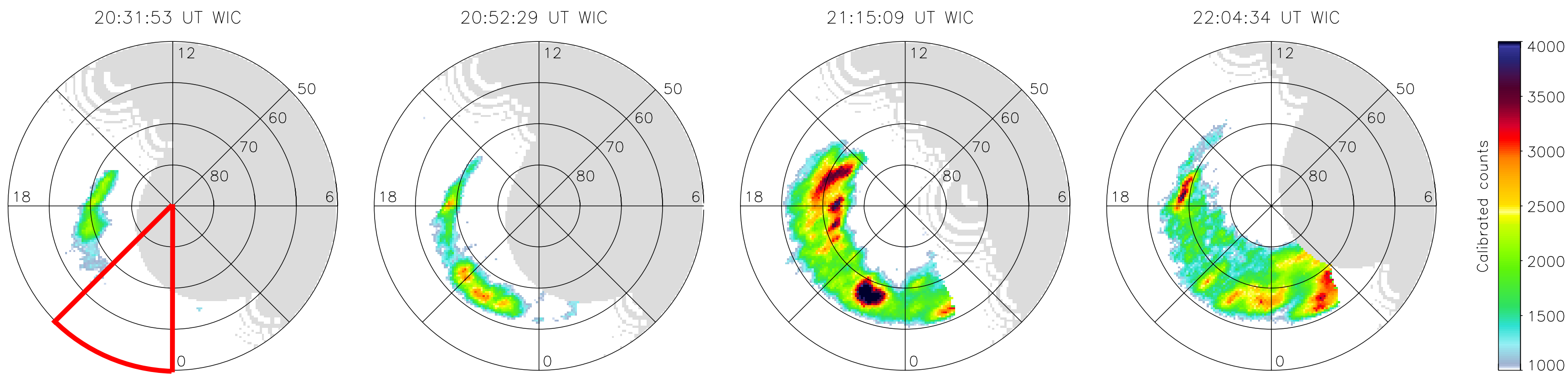
2000–12–09



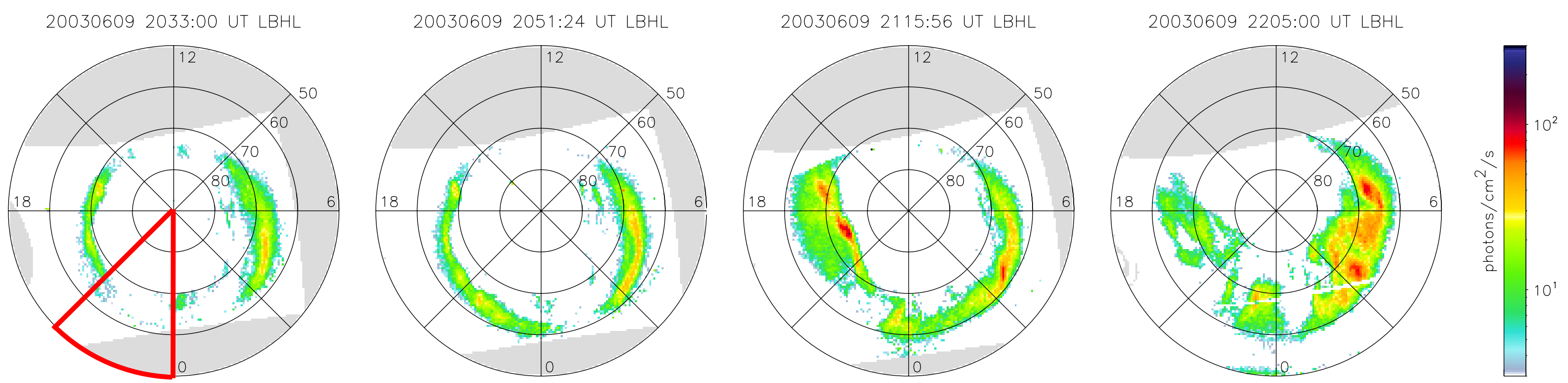
- Magnitude and slope of adjusted WIC and LBHL integrated photon fluxes are approximately equal – except on 2000–12–09 → time resolution/FOV/limb
- Magnitude and slope of LBHS integrated photon fluxes appear different – sensitive to energy of precipitation

Conjugate Observations

IMAGE WIC: Northern Hemisphere (Sunlit)



Polar UVI: Southern Hemisphere (Dark)



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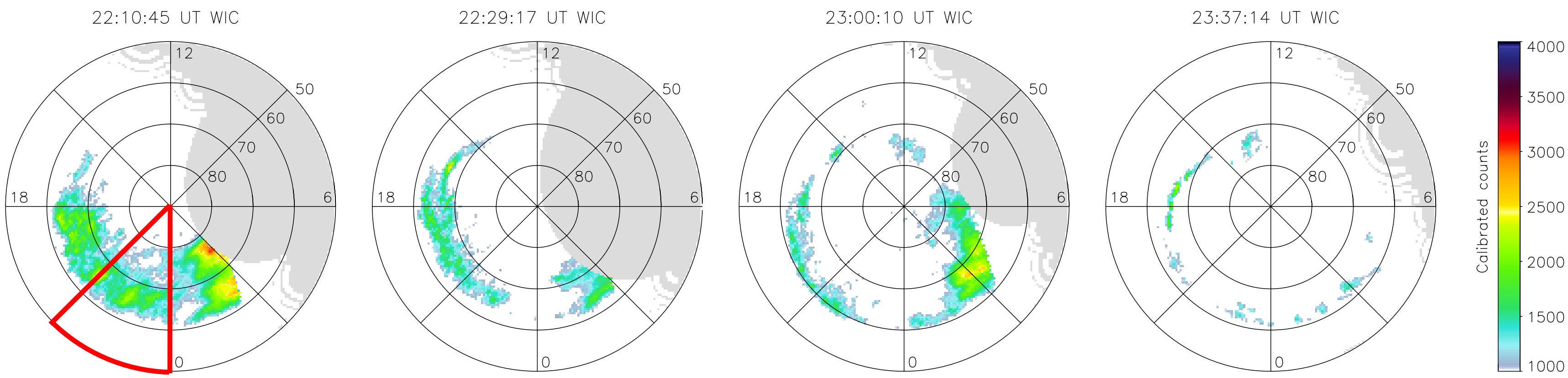

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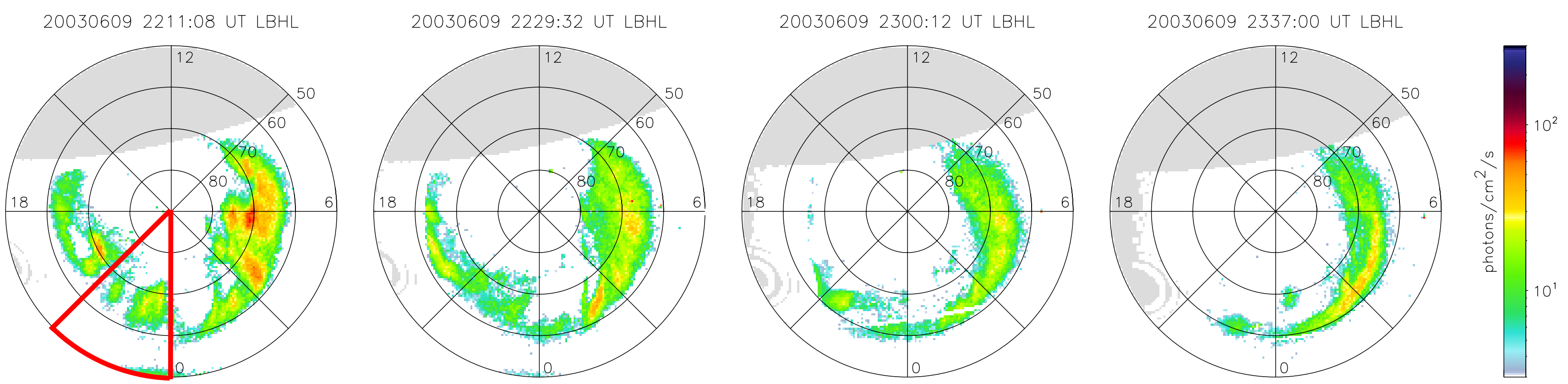
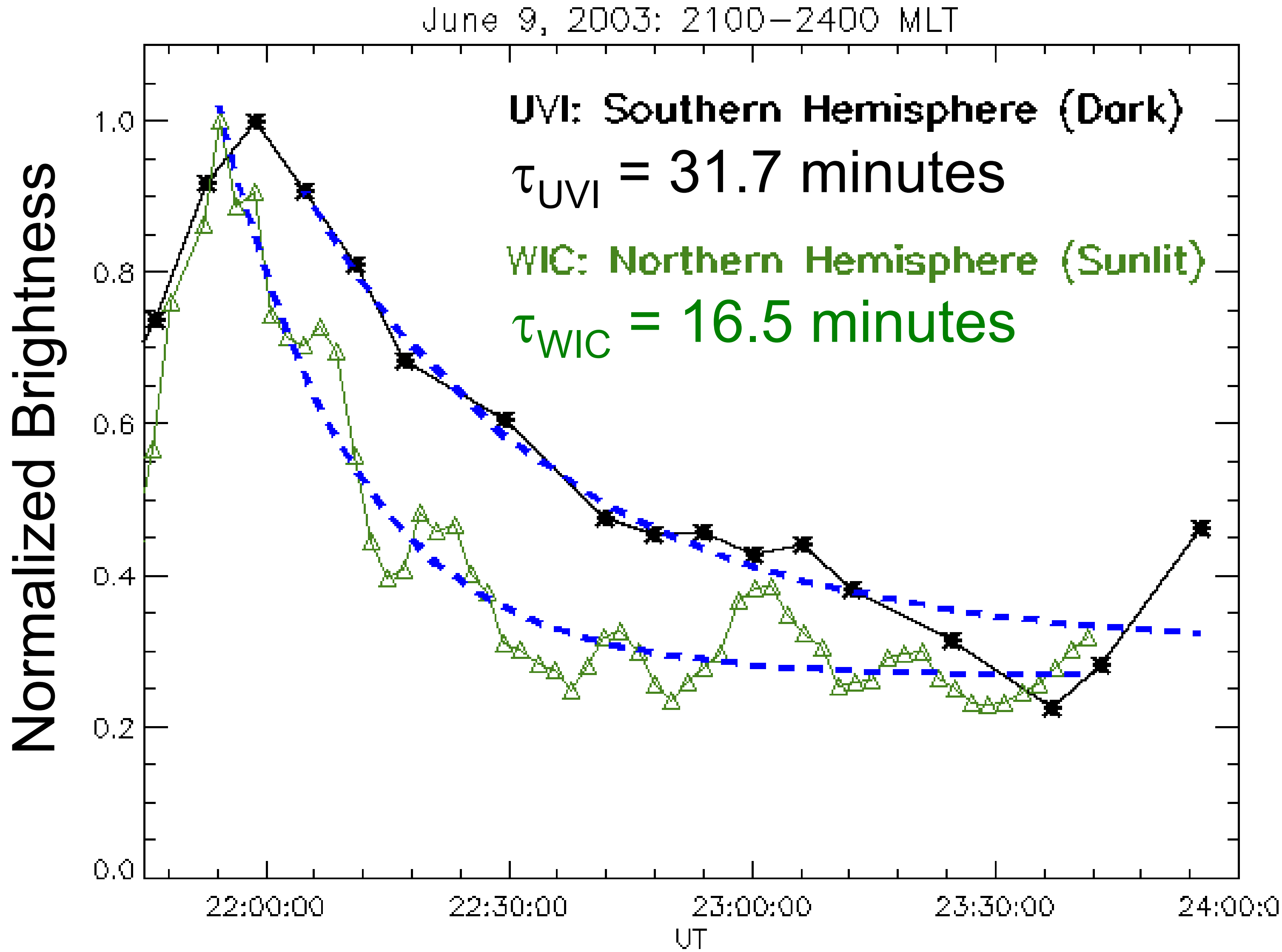


Recovery Time



Summary & Conclusions

- WIC and UVI (usually) have similar profiles/time scales
  → discrepancy not due to filter effect → statistics (?)

- Simultaneous, conjugate substorm observations show recovery time is **nearly double** in dark hemisphere in agremeent with statistical results of *Chua et al.* [2004]

Challenges using multiple data sources/instruments

- Differences in spectral response
  → Complicates quantitative comparisons
- Differences in spatial coverage/orbits
  → Complicates conjugate studies (local, not global)

➔ Two (or more) identical instruments in opposite orbits