Seasonal Variation of Substorm Recovery Time Scales

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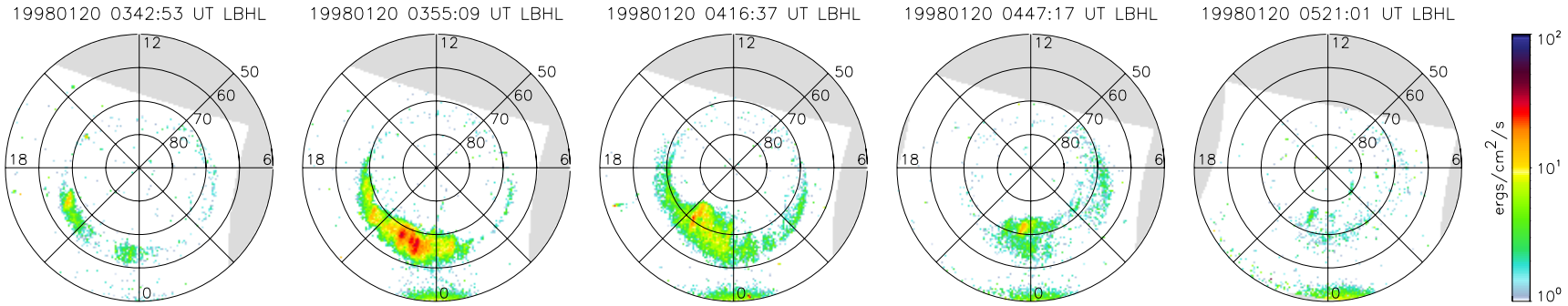
SM41A-04 2007 Joint Assembly, Acapulco, Mexico 24 May 2007

Outline

1. Quantification of auroral substorm development
   - Energy deposition by particle precipitation: peak hemispheric power, total energy deposition
   - Time scales: expansion time, **recovery time** (τ)
2. Statistical study of auroral substorm characteristics; 350 substorms from Polar UVI [see *Chua et al.*, 2004]
   - IMF orientation
   - Season ➔ **Implications for auroral conjugacy**
3. Simultaneous, conjugate substorm observations

   Do auroral substorms develop differently in each hemisphere?

Quantitative description of auroral substorms

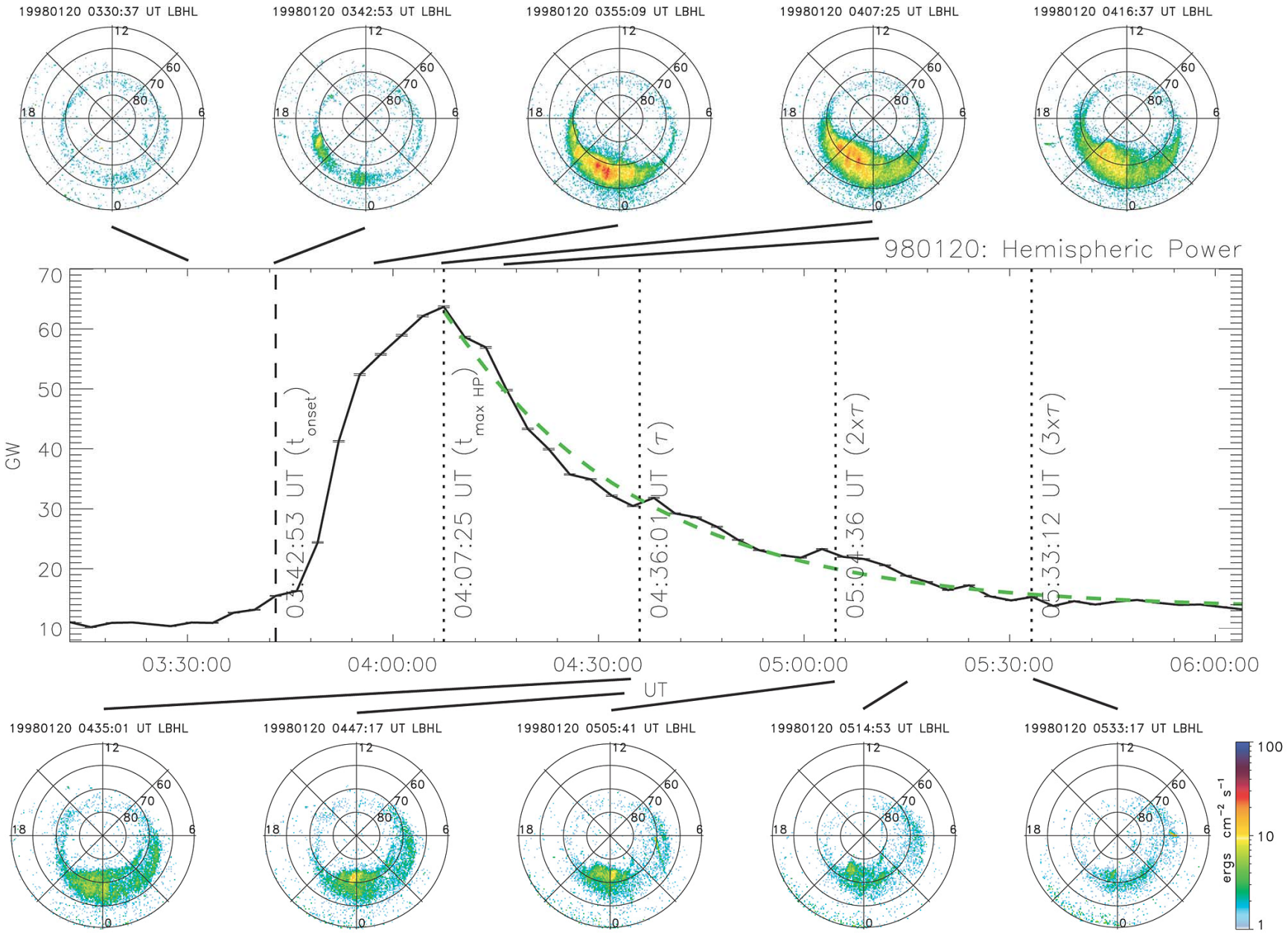


Hemispheric Power, $$HP = \sum_{i=1}^{m} \sum_{j=1}^{n} Q_{i,j} A_{i,j}$$

where m, n = pixel indices

$Q_{i,j}$ = energy flux [$mW\ m^{-2}$]

$A_{i,j}$ = projected area of pixel(i, j) [m^2]



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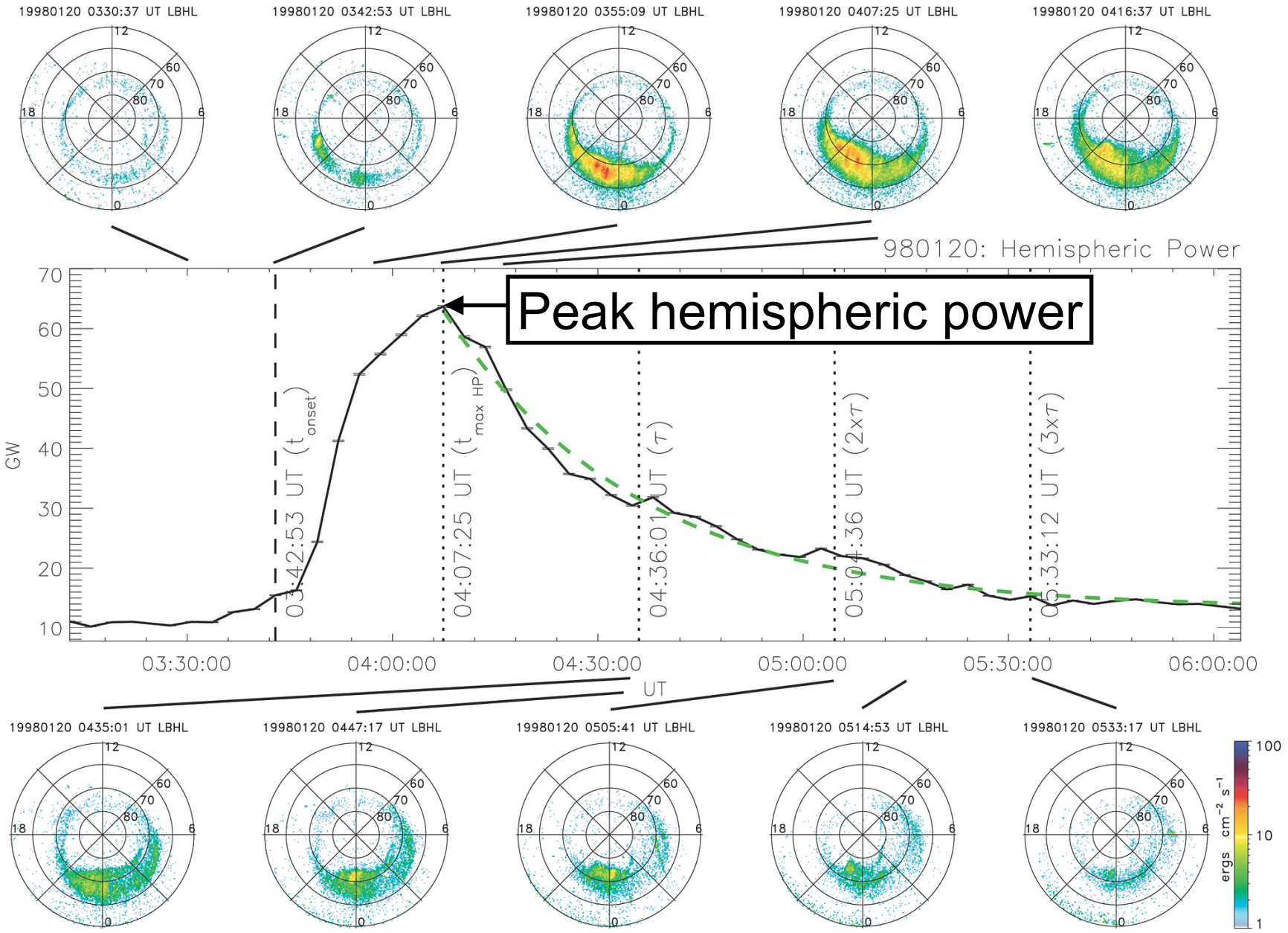
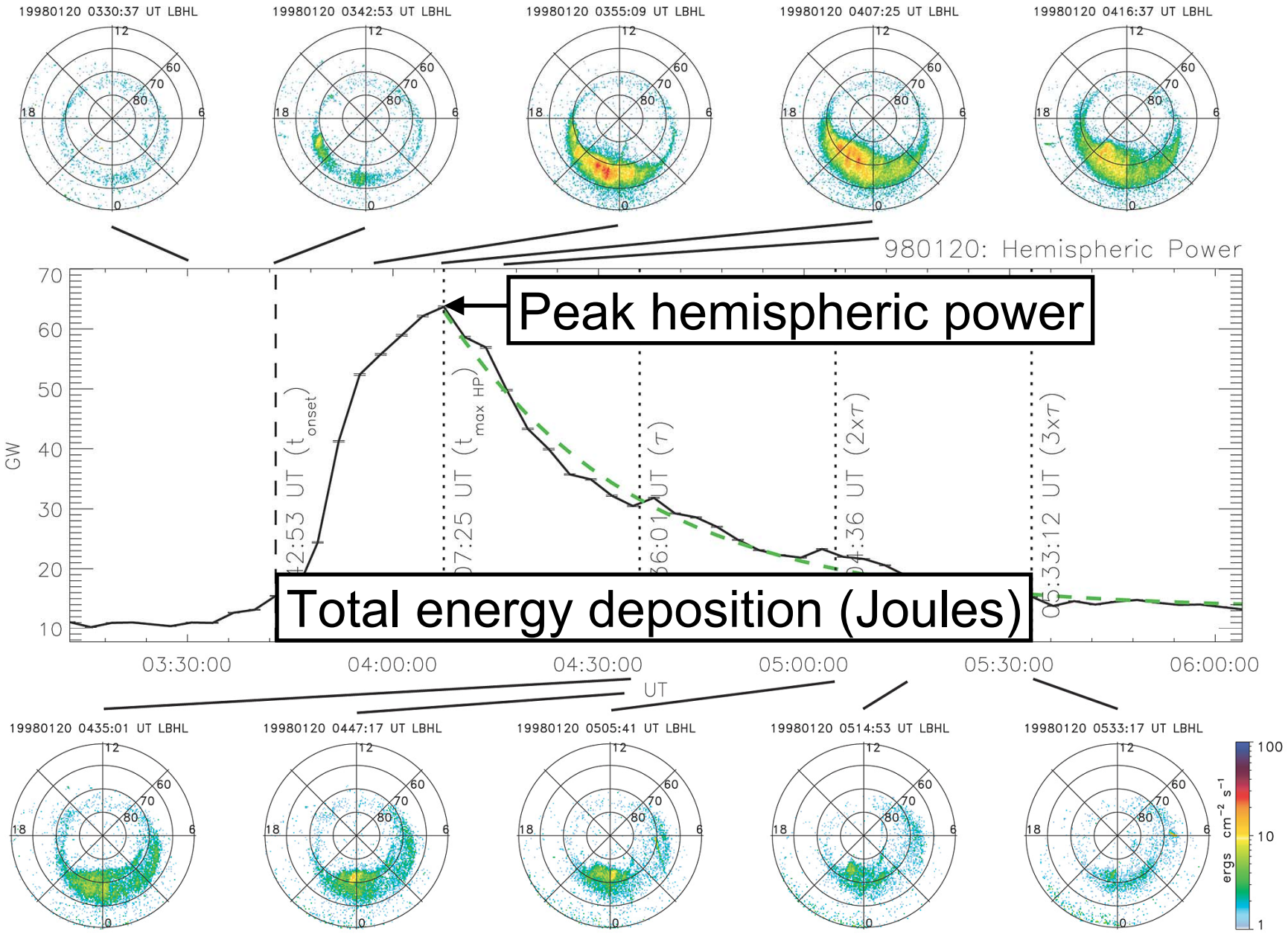

19980120 0330:37 UT LBHL
19980120 0342:53 UT LBHL
19980120 0355:09 UT LBHL
19980120 0407:25 UT LBHL
19980120 0416:37 UT LBHL
980120: Hemispheric Power
Peak hemispheric power
GW
03:42:53 UT (t onset)
04:07:25 UT (t max HP)
04:36:01 UT (τ)
05:04:36 UT (2xτ)
05:33:12 UT (3xτ)
03:30:00
04:00:00
04:30:00
05:00:00
05:30:00
06:00:00
UT
19980120 0435:01 UT LBHL
19980120 0447:17 UT LBHL
19980120 0505:41 UT LBHL
19980120 0514:53 UT LBHL
19980120 0533:17 UT LBHL
ergs cm-2 s-1



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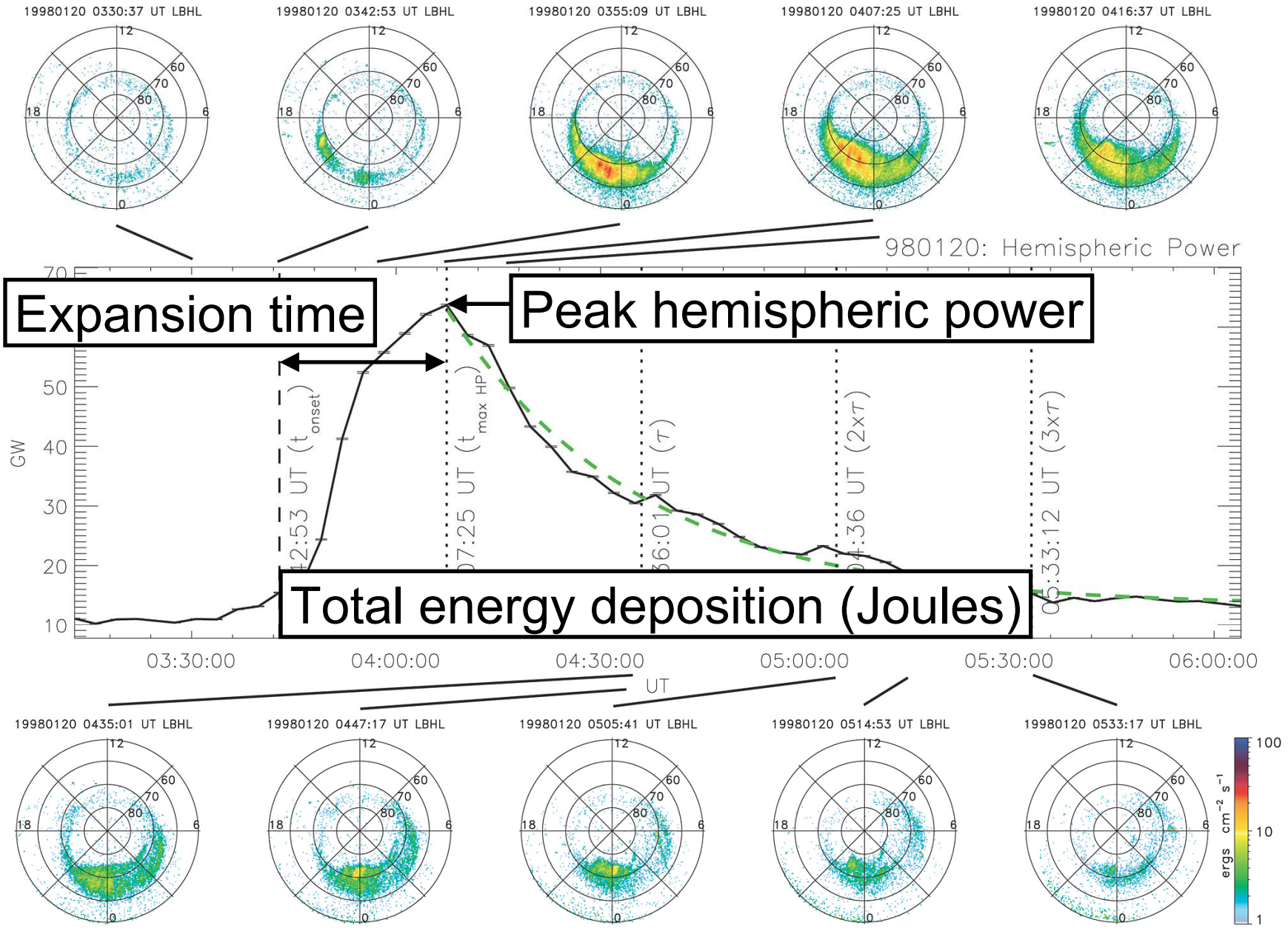

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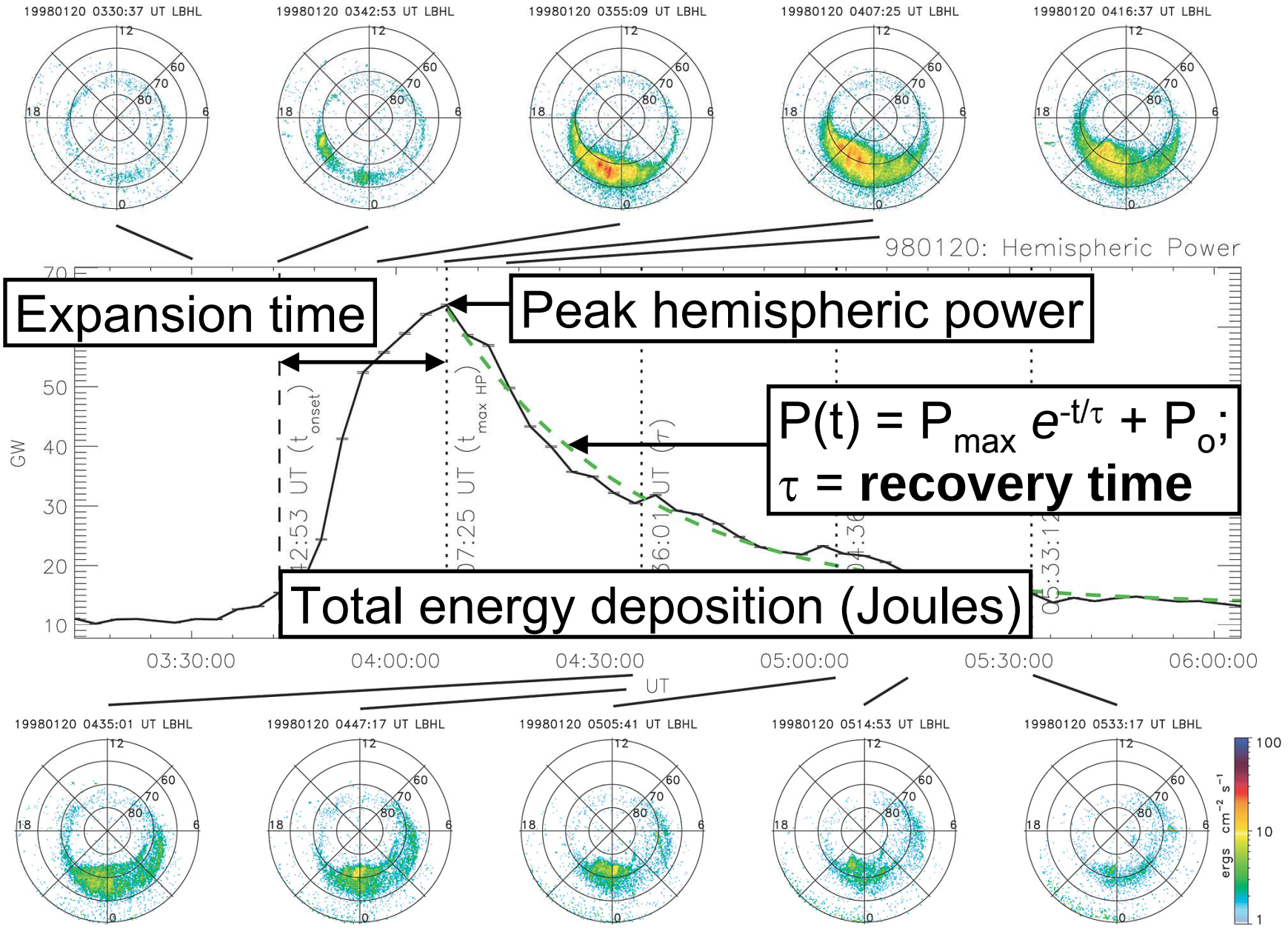
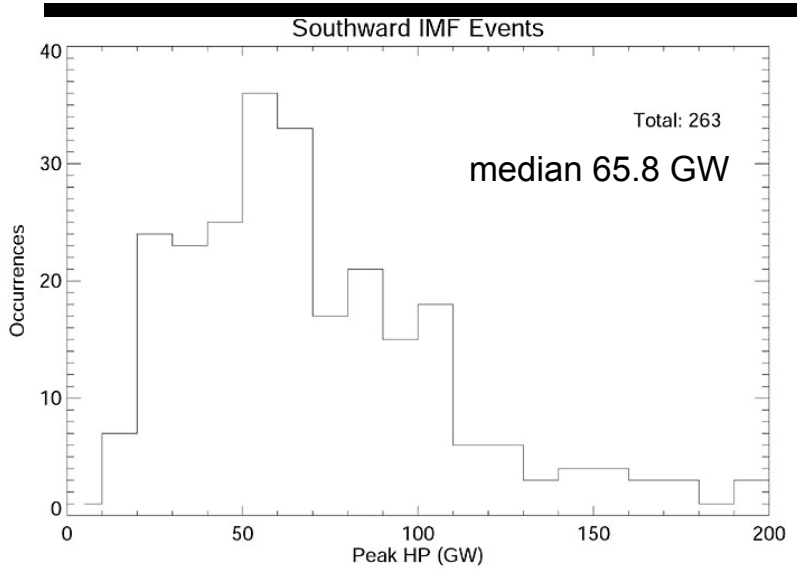
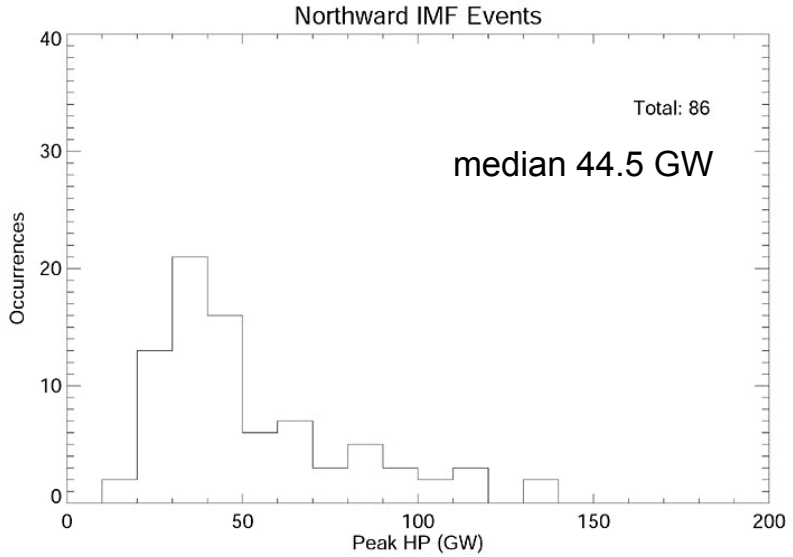
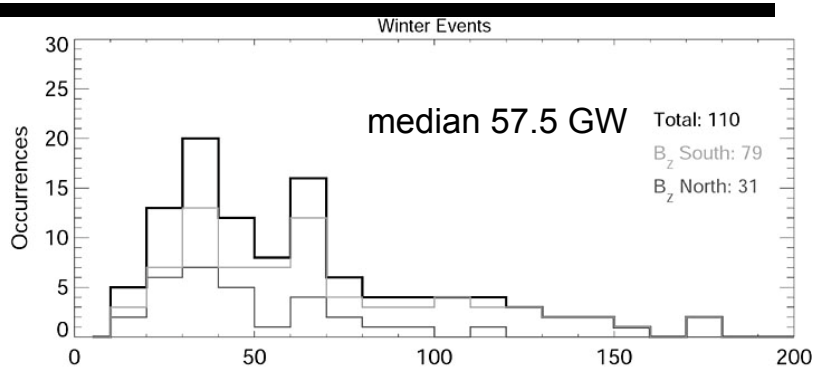

19980120 0330:37 UT LBHL
19980120 0342:53 UT LBHL
19980120 0355:09 UT LBHL
19980120 0407:25 UT LBHL
19980120 0416:37 UT LBHL
980120: Hemispheric Power
Expansion time
Peak hemispheric power
P(t) = P_max e^-t/τ + P_o;
τ = recovery time
Total energy deposition (Joules)
GW
UT
03:30:00
04:00:00
04:30:00
05:00:00
05:30:00
06:00:00
19980120 0435:01 UT LBHL
19980120 0447:17 UT LBHL
19980120 0505:41 UT LBHL
19980120 0514:53 UT LBHL
19980120 0533:17 UT LBHL
ergs cm^-2 s^-1

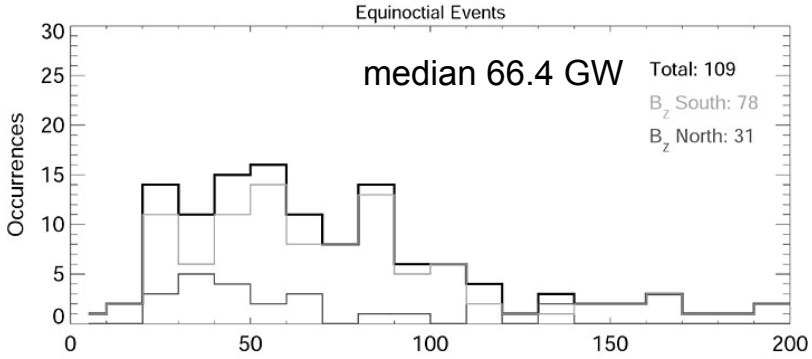
Peak Hemispheric Power

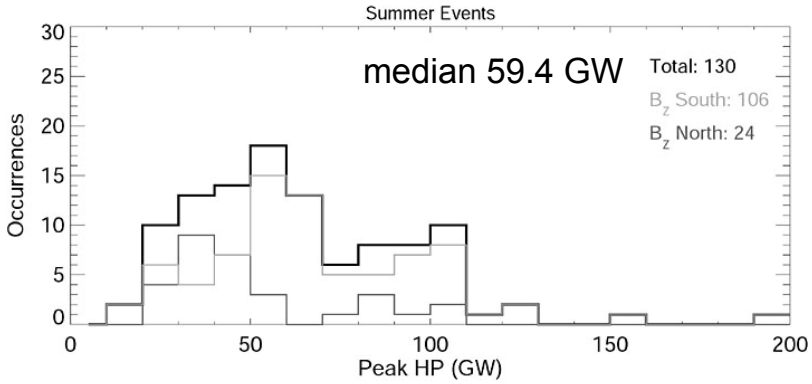




IMF Orientation

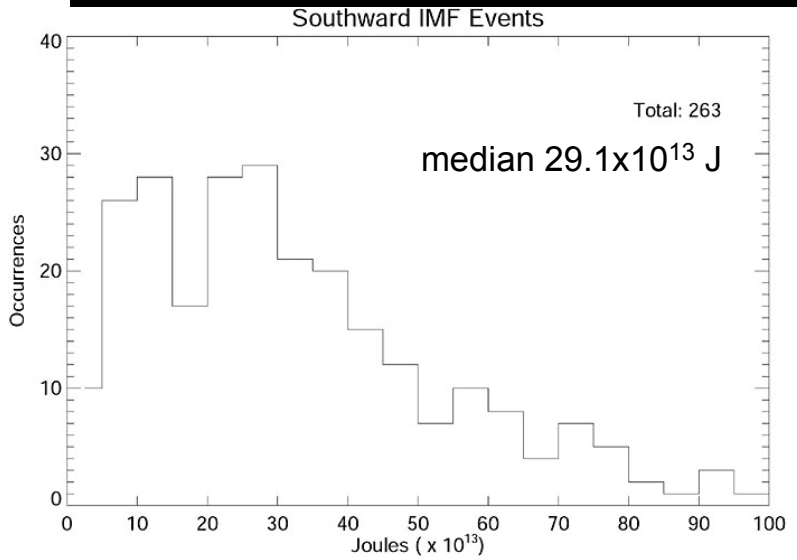


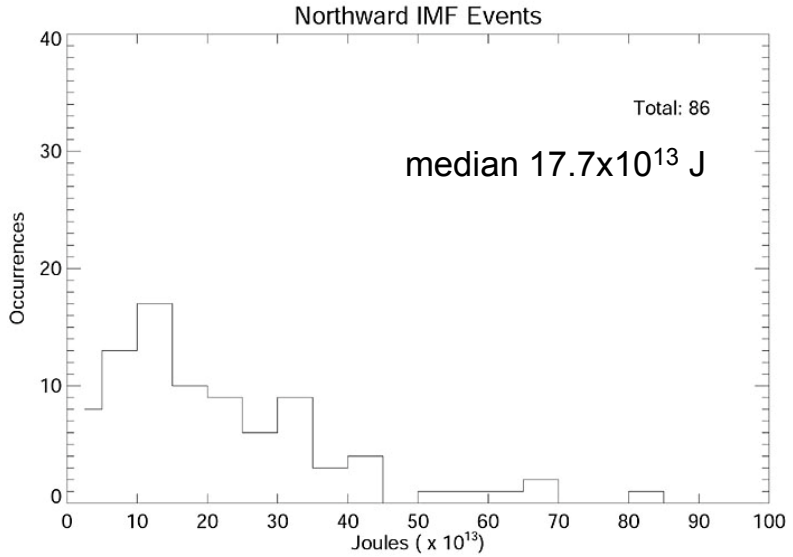




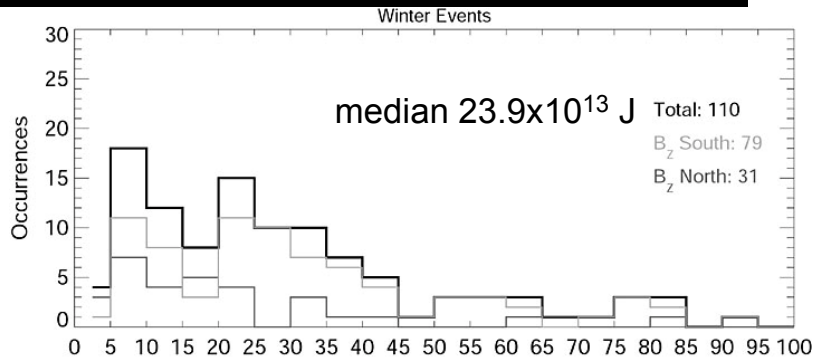
Season

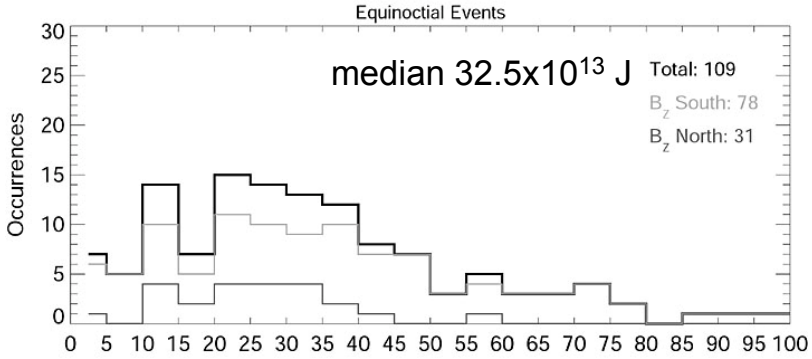
Total Energy Deposition

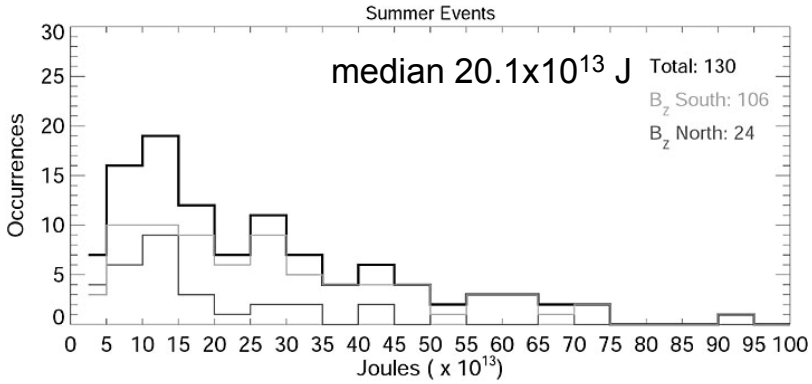




IMF Orientation

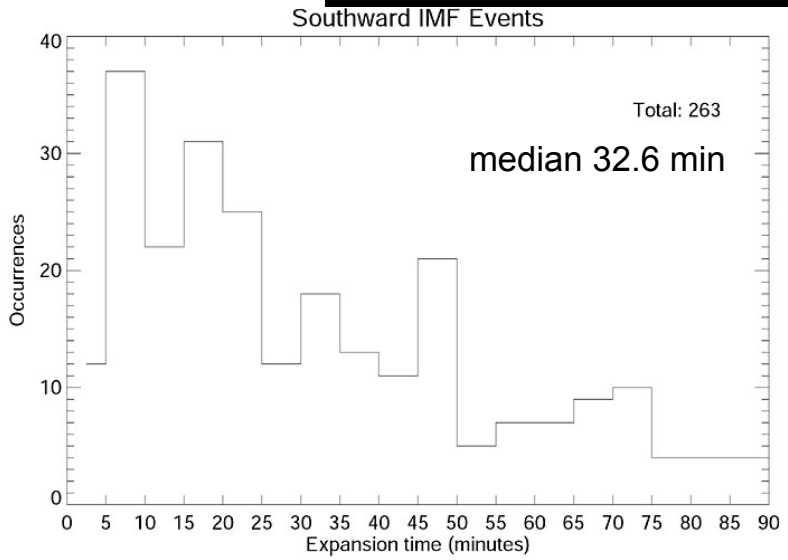


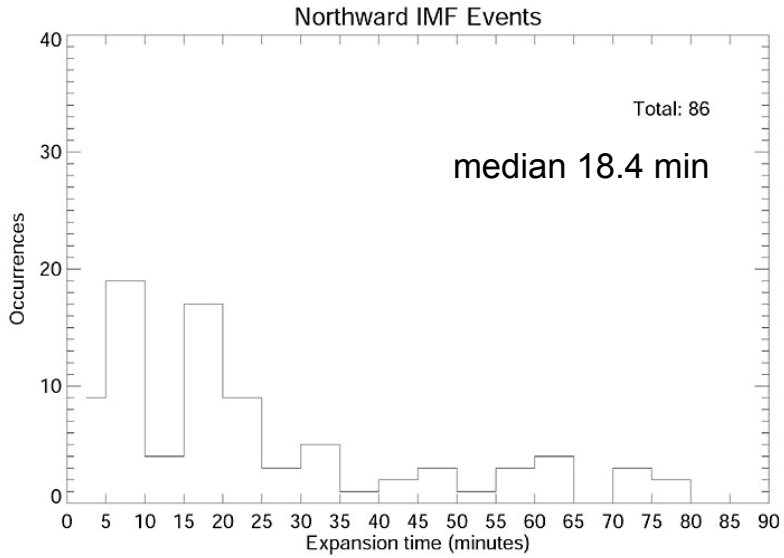




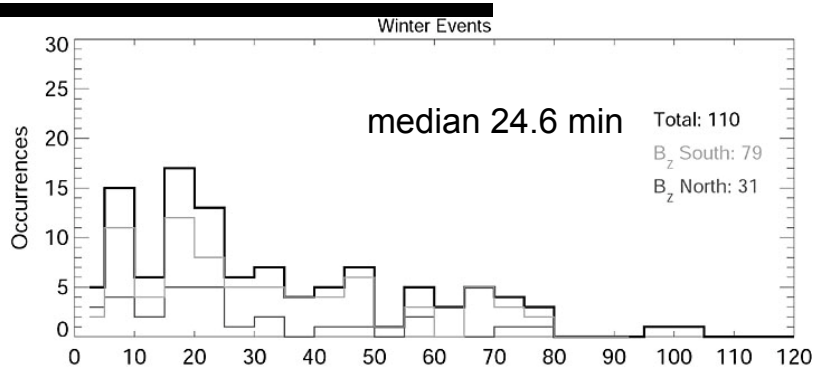
Season

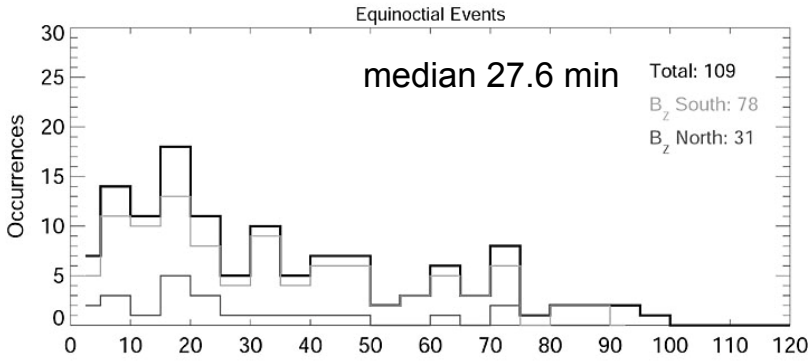
Expansion Time

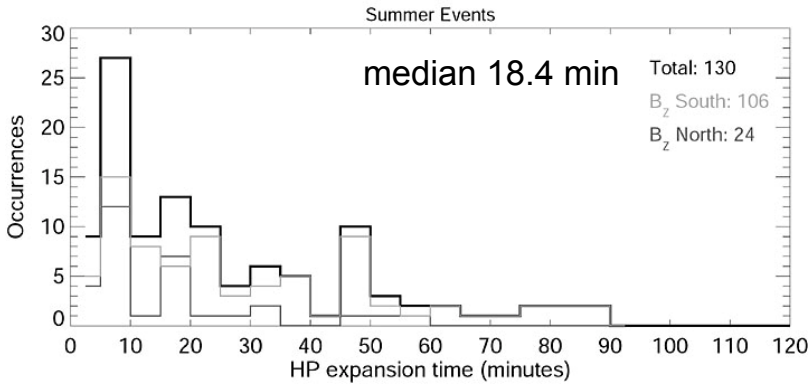




IMF Orientation



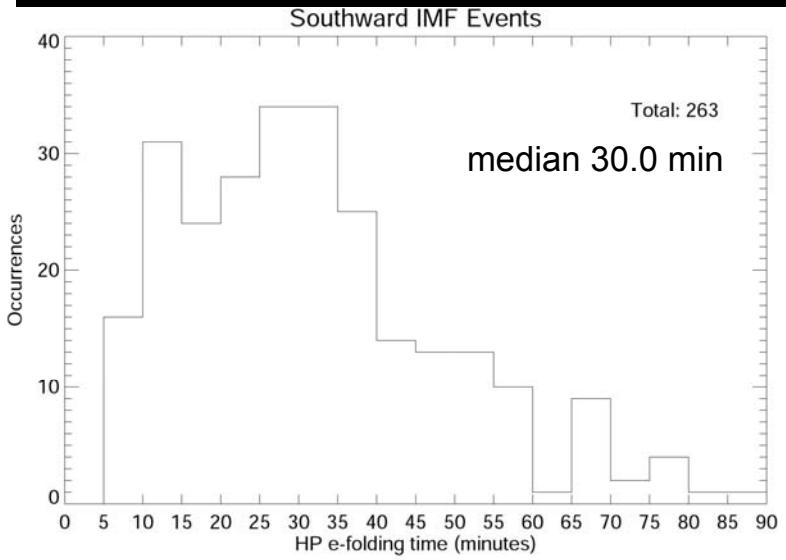


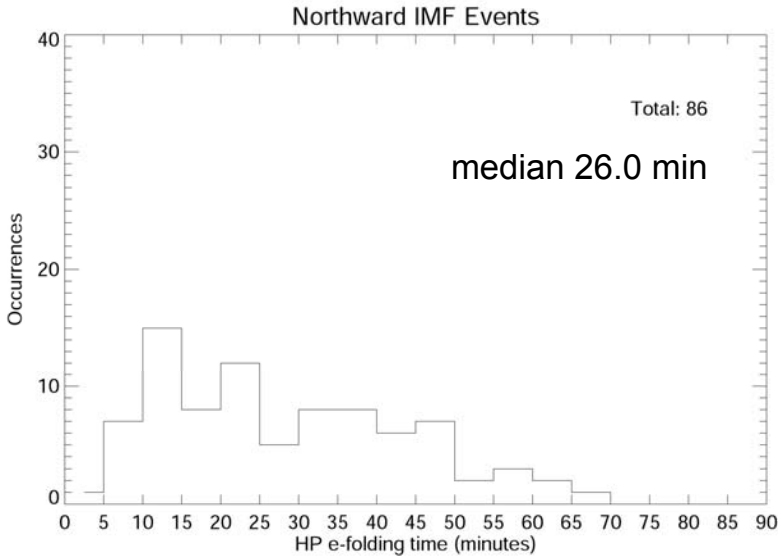


Season

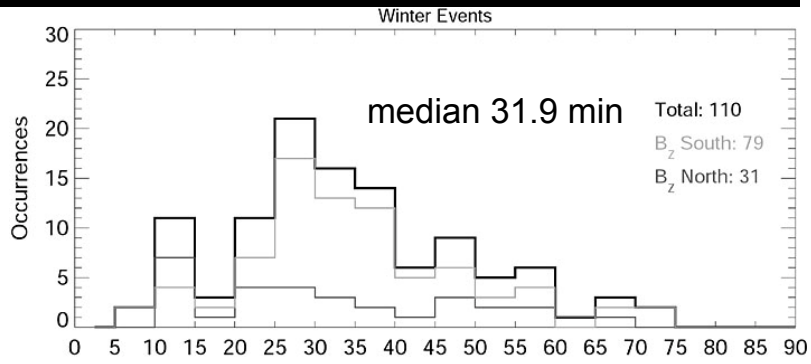
Recovery (*e*-folding) Time

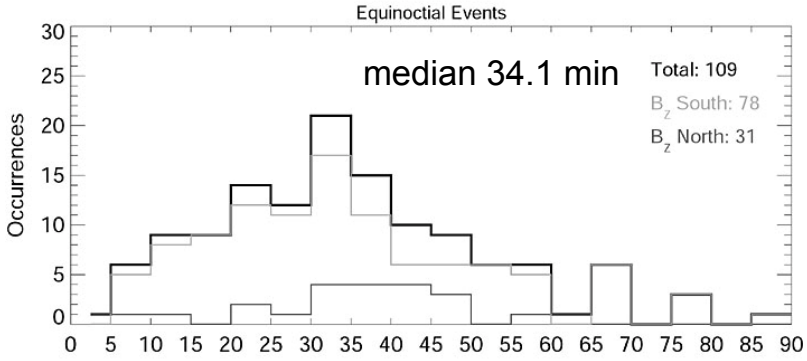
IMF Orientation

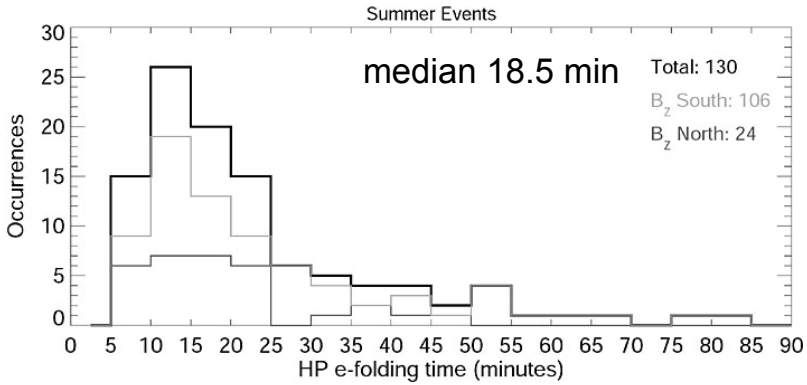




Season







Summary

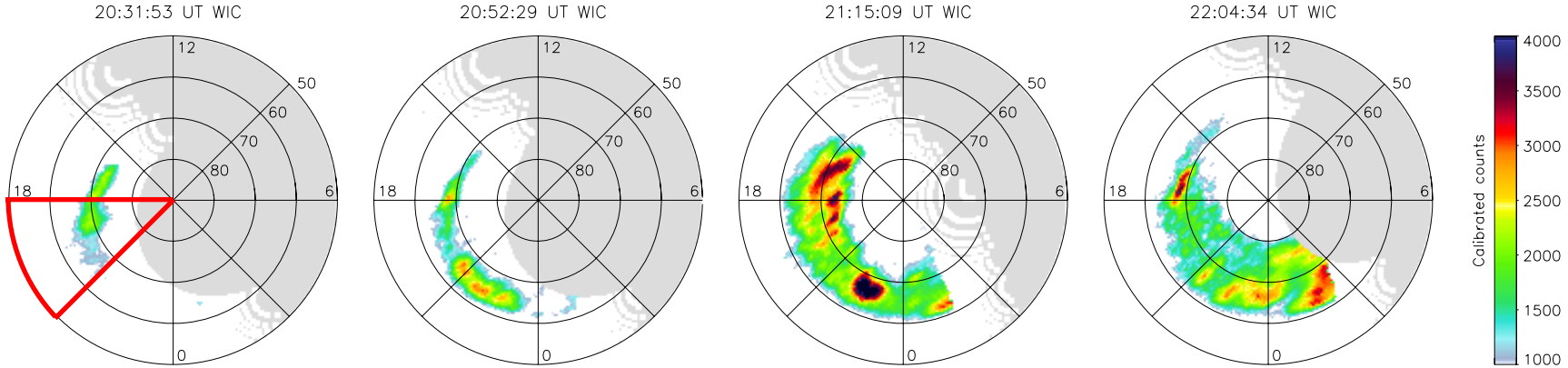
variation of ↓ with →	IMF Orientation	**Season**
Peak hemispheric power	50%	**15%**
Total energy deposition	65%	**60%**
Expansion time	80%	**60%**
Recovery time	15%	**80%**

Implications for auroral conjugacy:

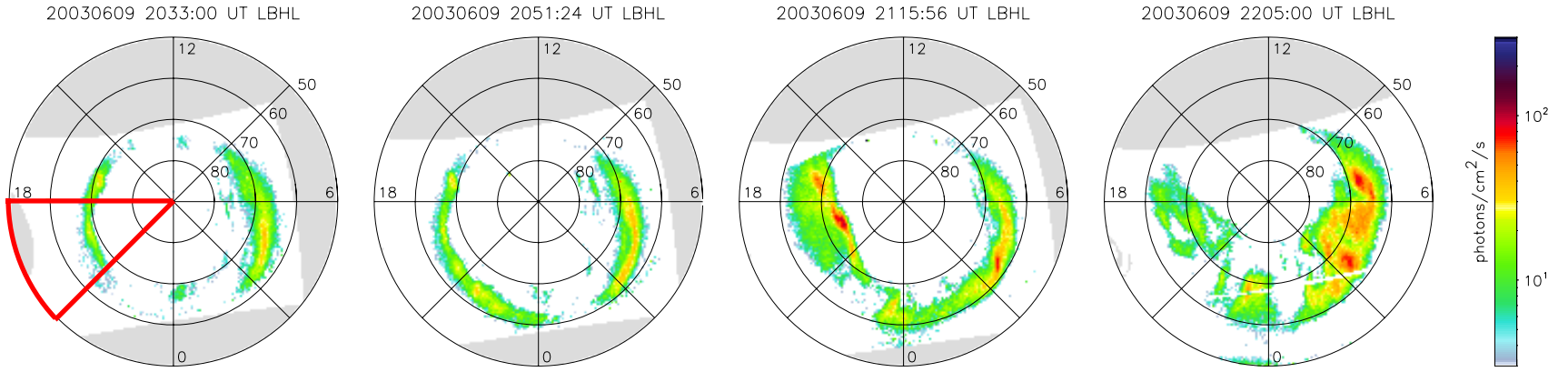
- **Statistically**, auroral substorms **last longer** in darkness (winter) than in sunlight (summer)
- **More energy** is deposited in the dark hemisphere
- **Does this hold true for individual events?**

Conjugate Observations

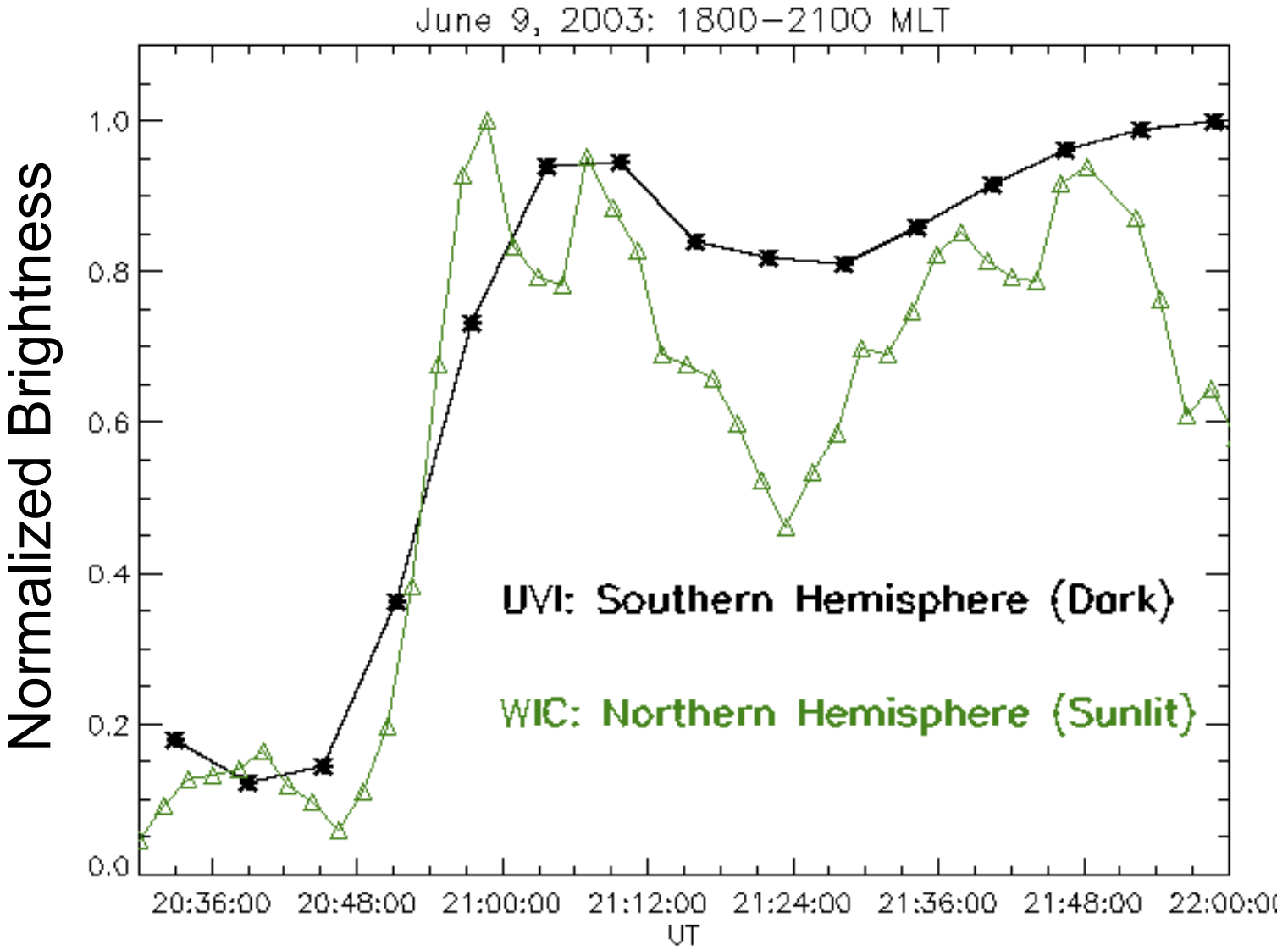
IMAGE WIC: Northern Hemisphere (Sunlit)



Polar UVI: Southern Hemisphere (Dark)

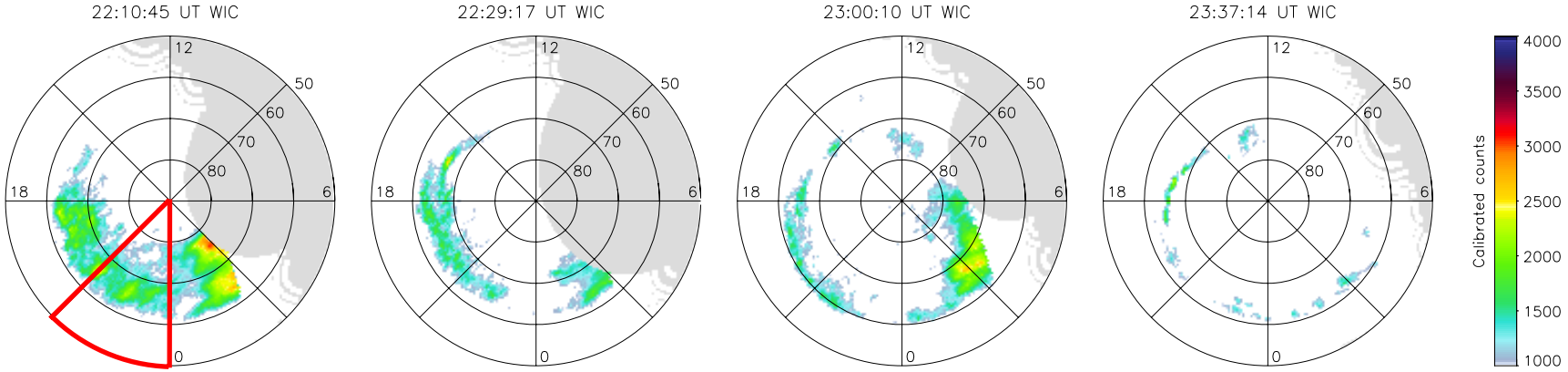


Expansion Time(?)

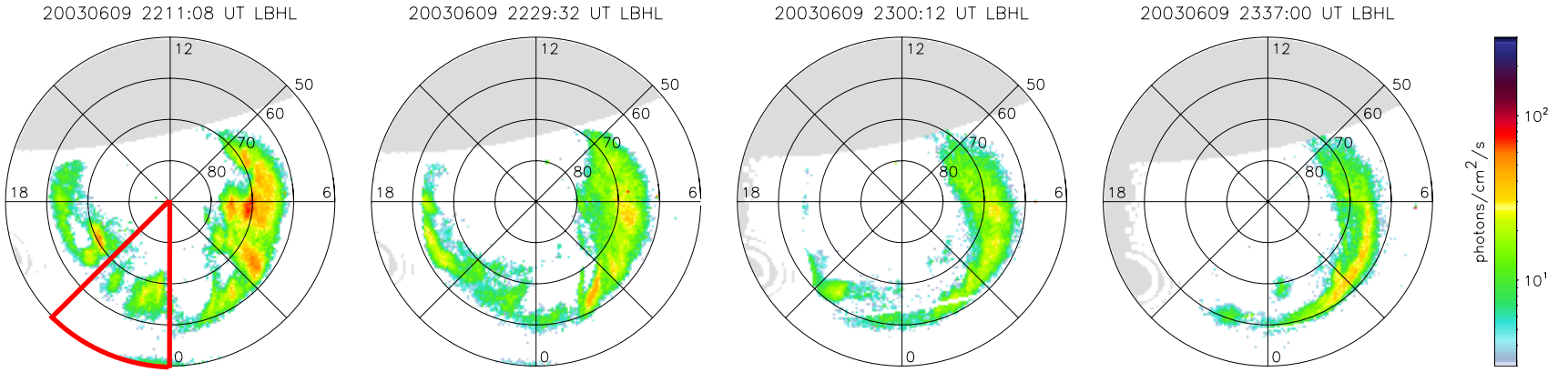


Conjugate Observations

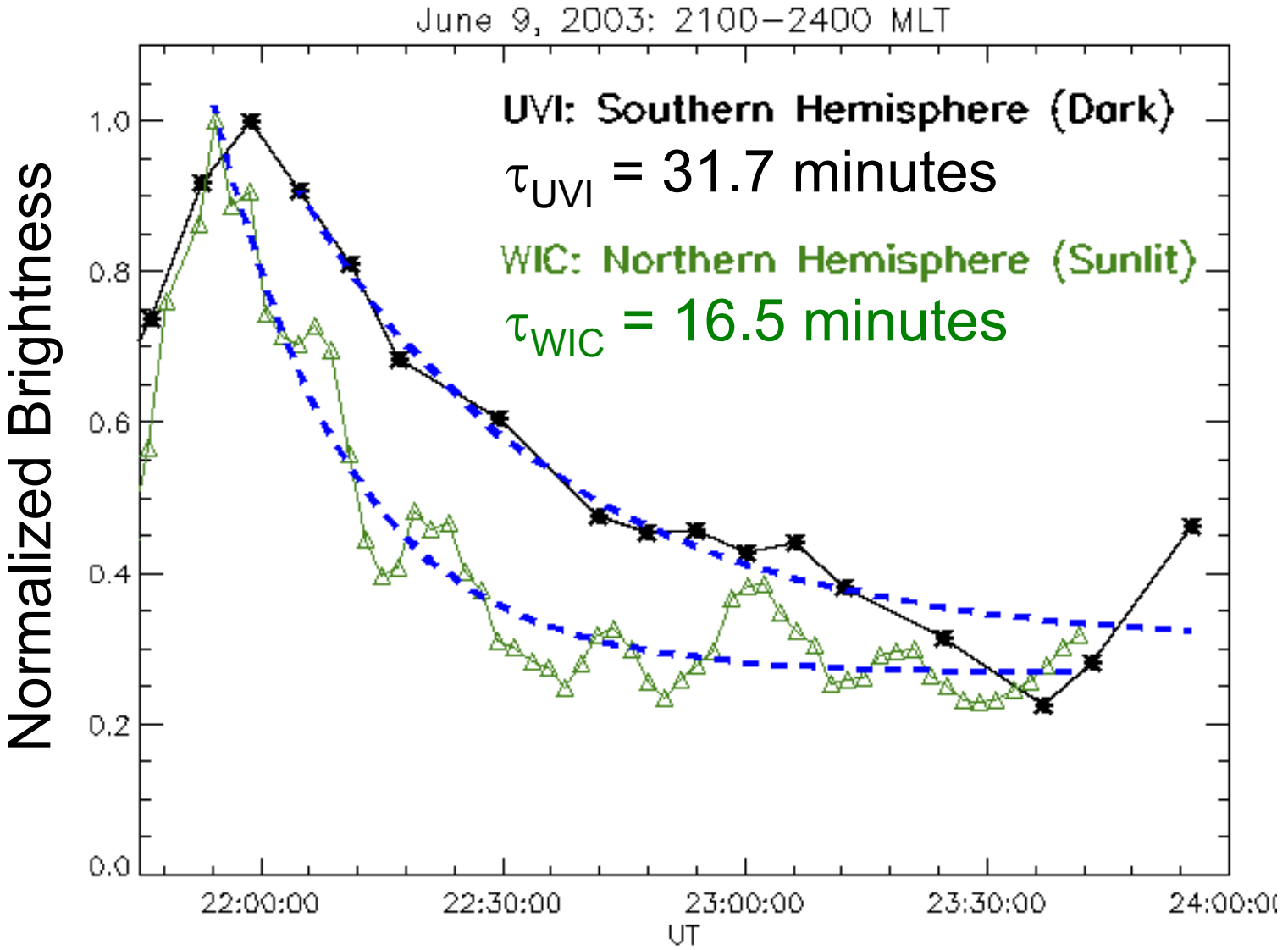
IMAGE WIC: Northern Hemisphere (Sunlit)



Polar UVI: Southern Hemisphere (Dark)



Recovery Time



Summary & Conclusions

- Both statistical study and simultaneous, conjugate observations suggest a **hemispheric difference** (**asymmetry**) in auroral substorm recovery times
- Recovery time is **nearly double** in dark hemisphere [*Caveats: small sample size of conjugate observations differences in instruments/filter responses*]

May be explained by effects of ionospheric conductivity

- Suppression of aurora in sunlight [*Newell et al.*, 2001]
- Conductivity plays major role in substorm dynamics

Asymmetric energy input during auroral substorms

➔ Implications for upper atmospheric dynamics