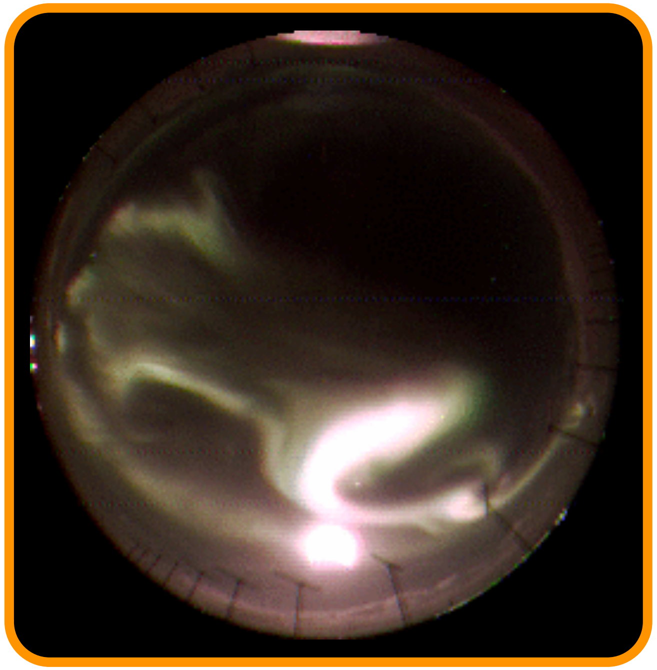
The Influence of Magnetospheric Substorms on SuperDARN Backscatter



Moonlight and aurora captured by the new Rainbow ASI at the Pykkvibær SuperDARN radar, Iceland on 20 Nov 2007.

J.A. Wild[1] & A. Grocott[2]

1. Space Plasma Environment and Radio Science Group, Dept. of Communication Systems, Lancaster University, UK.
2. Radio & Space Plasma Physics Group, Dept. of Physics & Astronomy, University of Leicester, UK.

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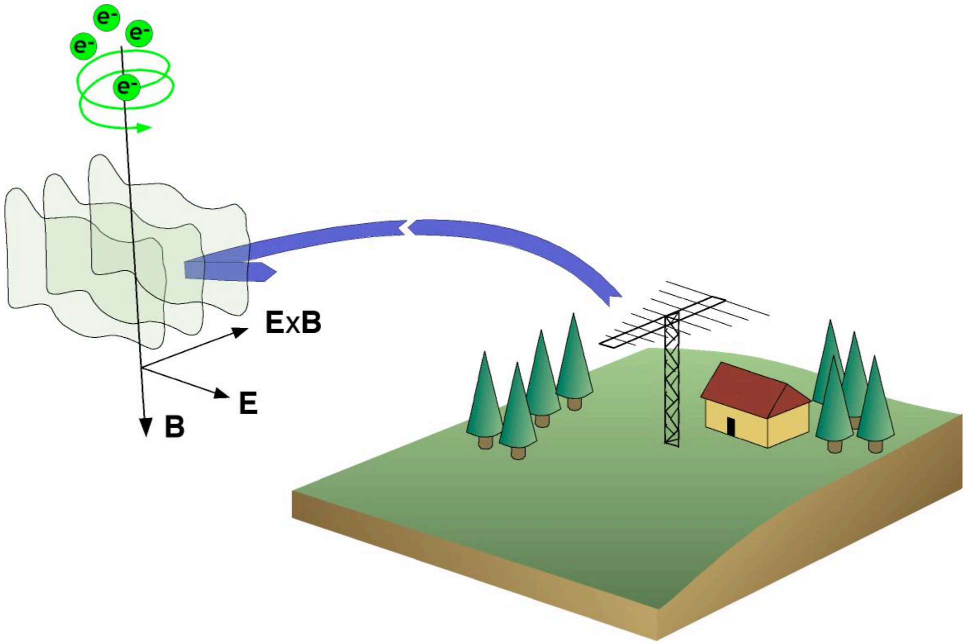
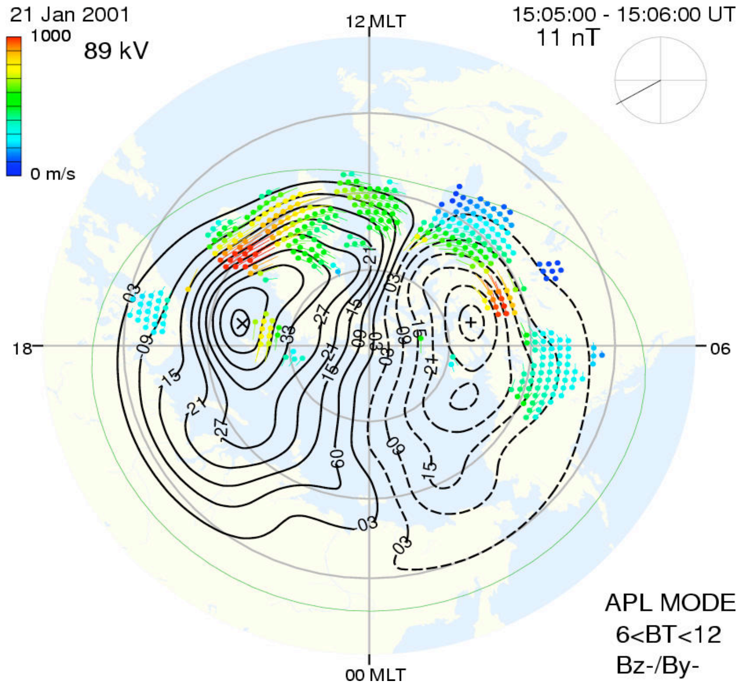
SuperDARN
A network of 19 coherent-scatter HF radars

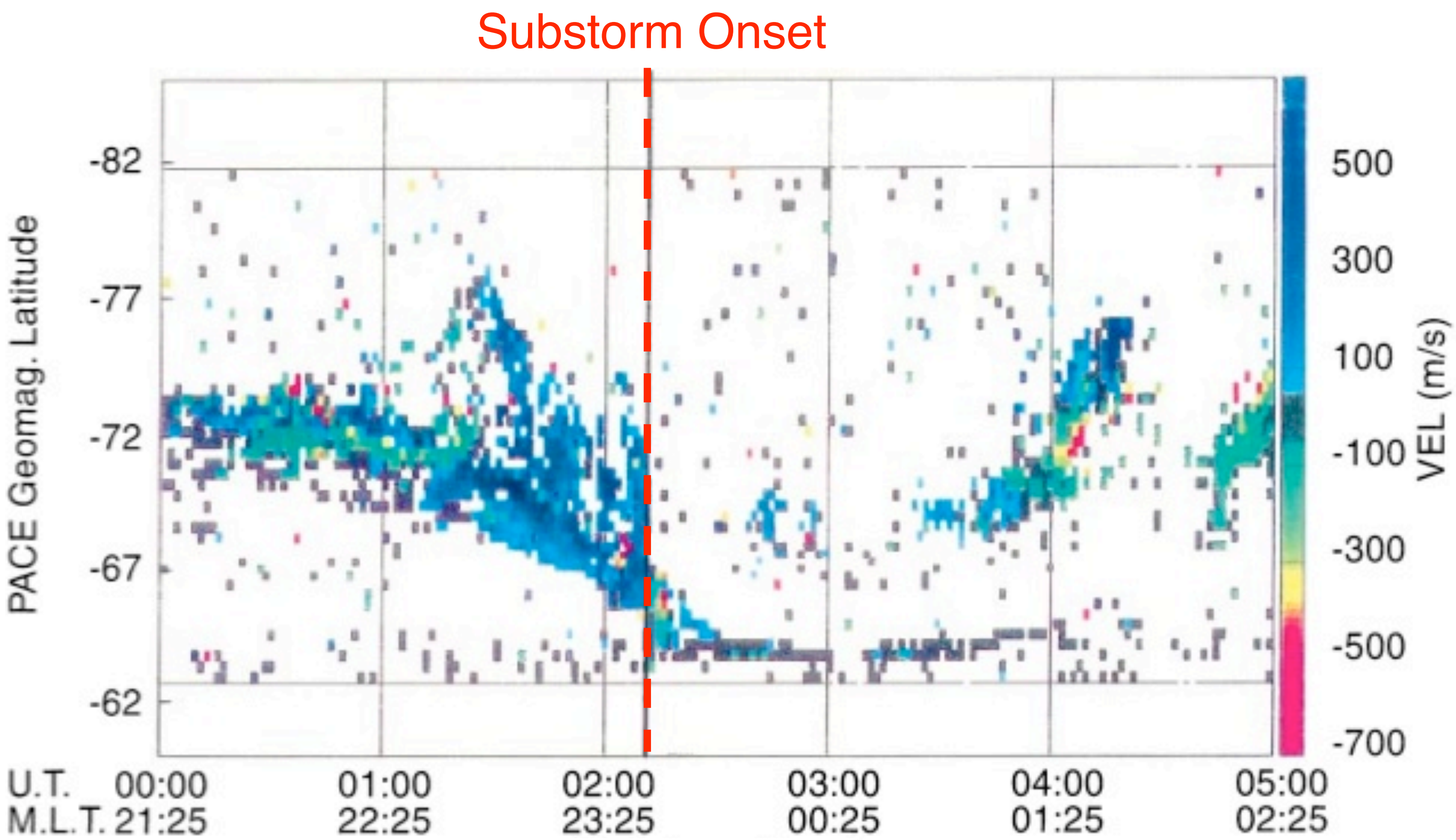




In order to detect backscatter...

- Irregularities must exist
- Radar signal must propagate to/from irregularities
- Signals must be orthogonal to irregularities

BACKGROUND & MOTIVATION

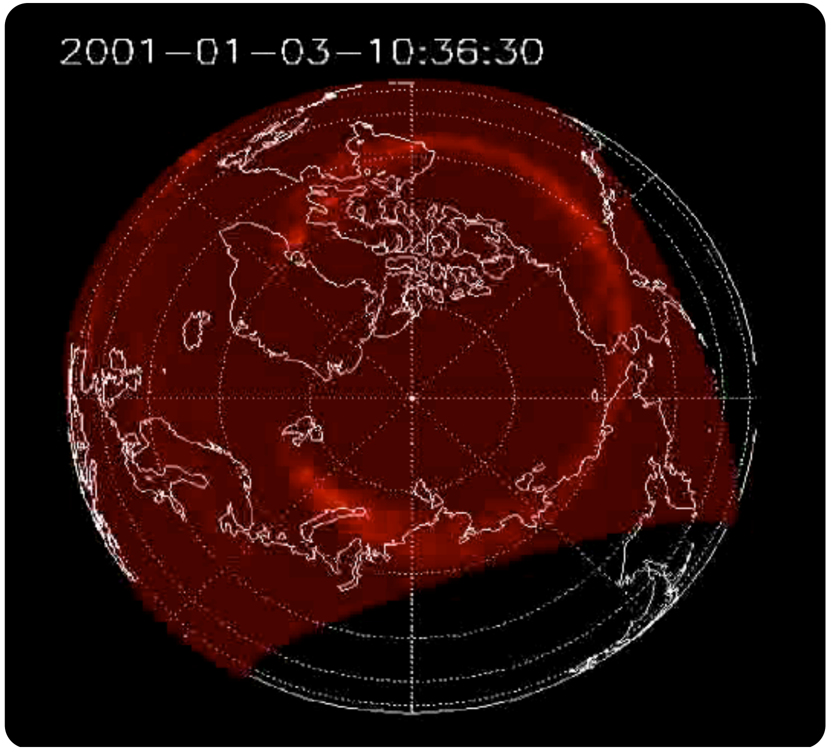


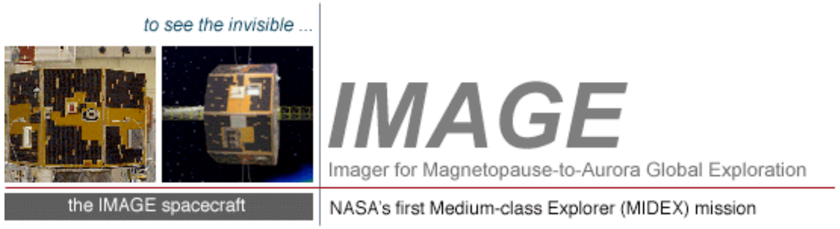
From Lewis et al., 1997.

IDENTIFYING SUBSTORMS: IMAGE

Prime data source were the WIC images (SI-13 images were used when WIC data were unavailable).

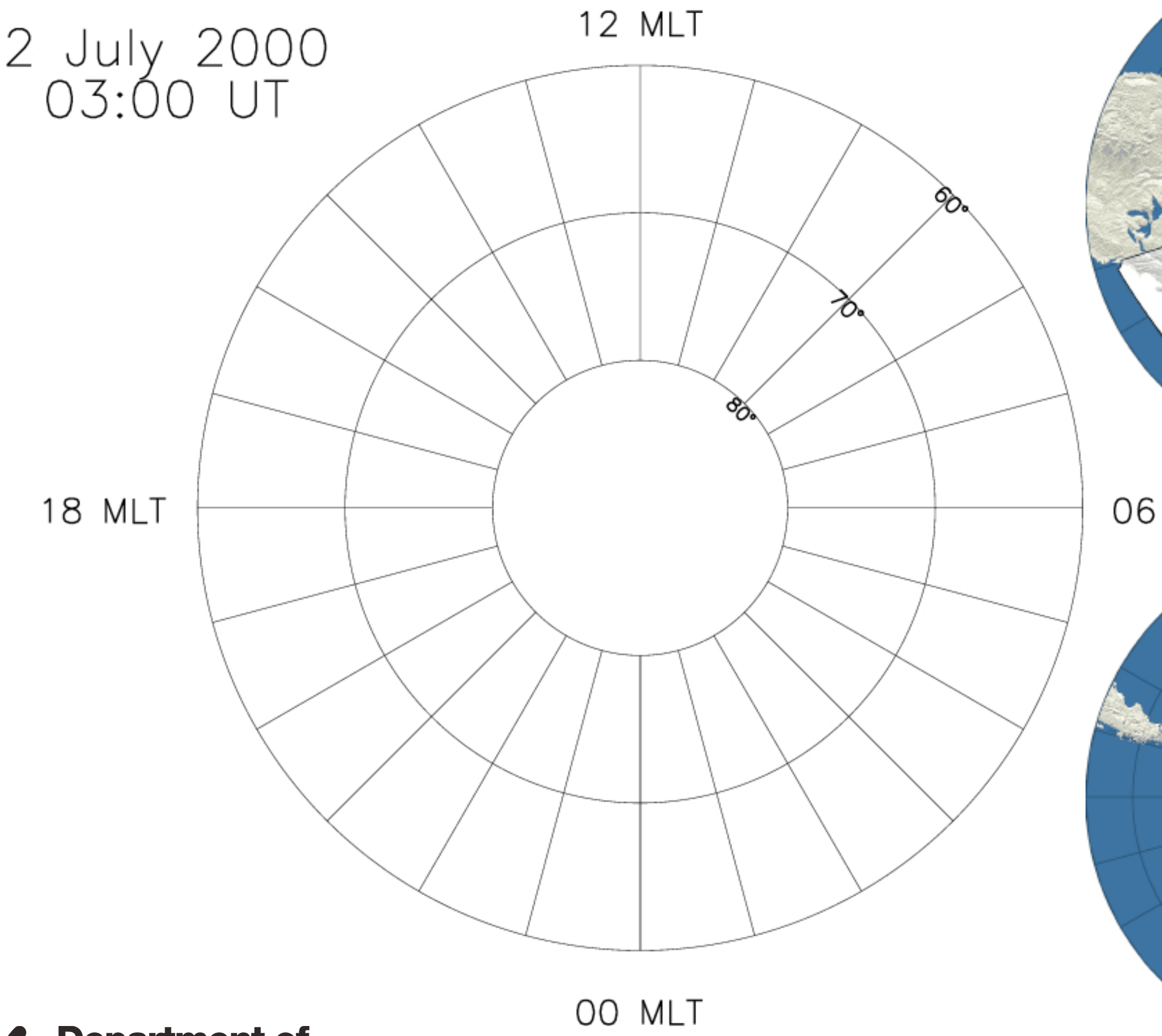
- a clear local brightening of the aurora has to occur
- the aurora has to expand to the poleward boundary of the auroral oval and spread azimuthally in local time for at least 20 min
- a substorm onset was only accepted as a separate event if at least 30 min had passed after the previous onset





SUBSTORM DATABASE

Frey et al. (2004) IMAGE WIC May 2000- Dec 2002	2437 substorms
IMAGE WIC May 2000- Dec 2005	4193 substorms
Exclude events within ±2 hours of another event	3005 substorms



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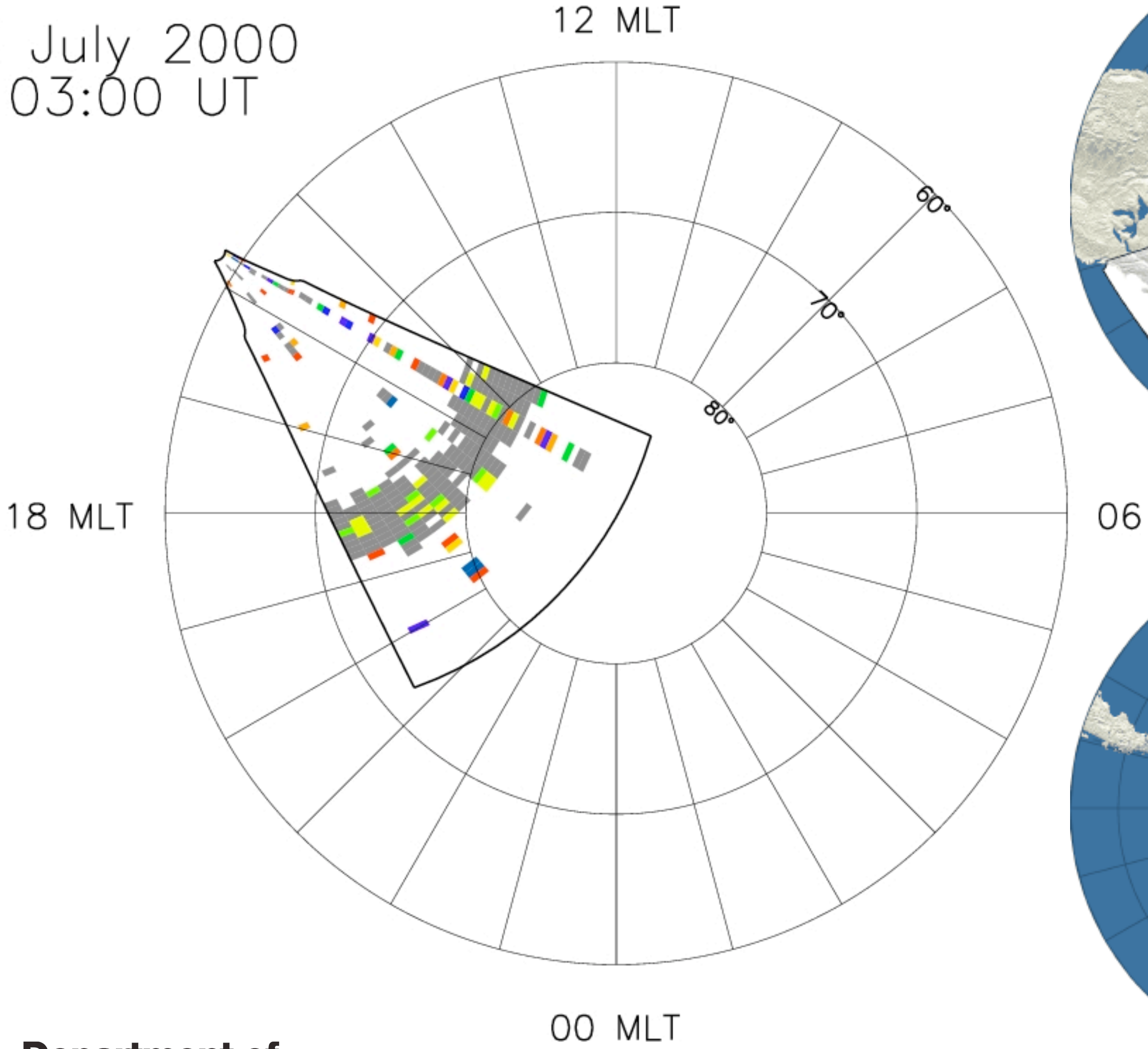
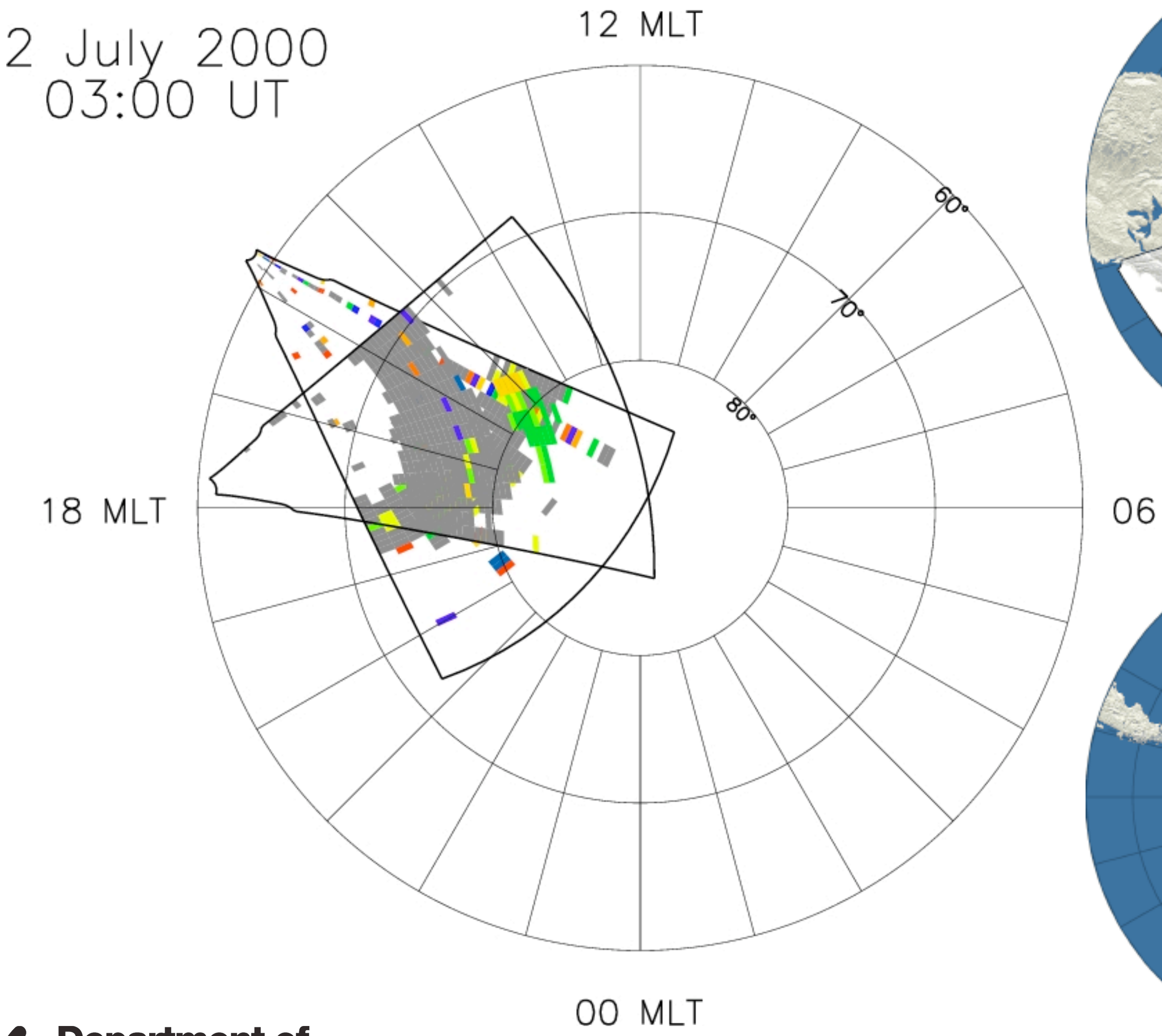
2 July 2000
03:00 UT





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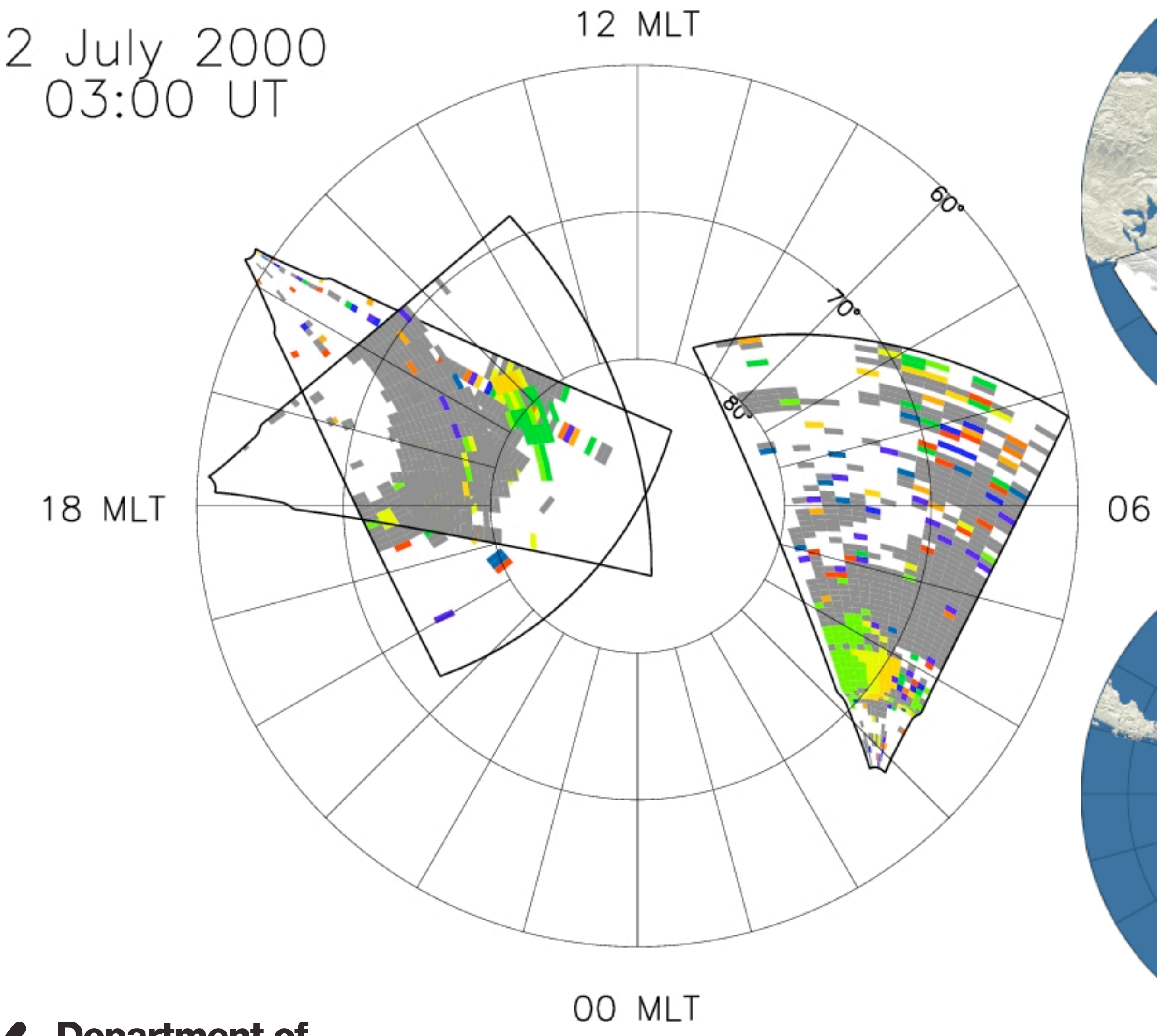

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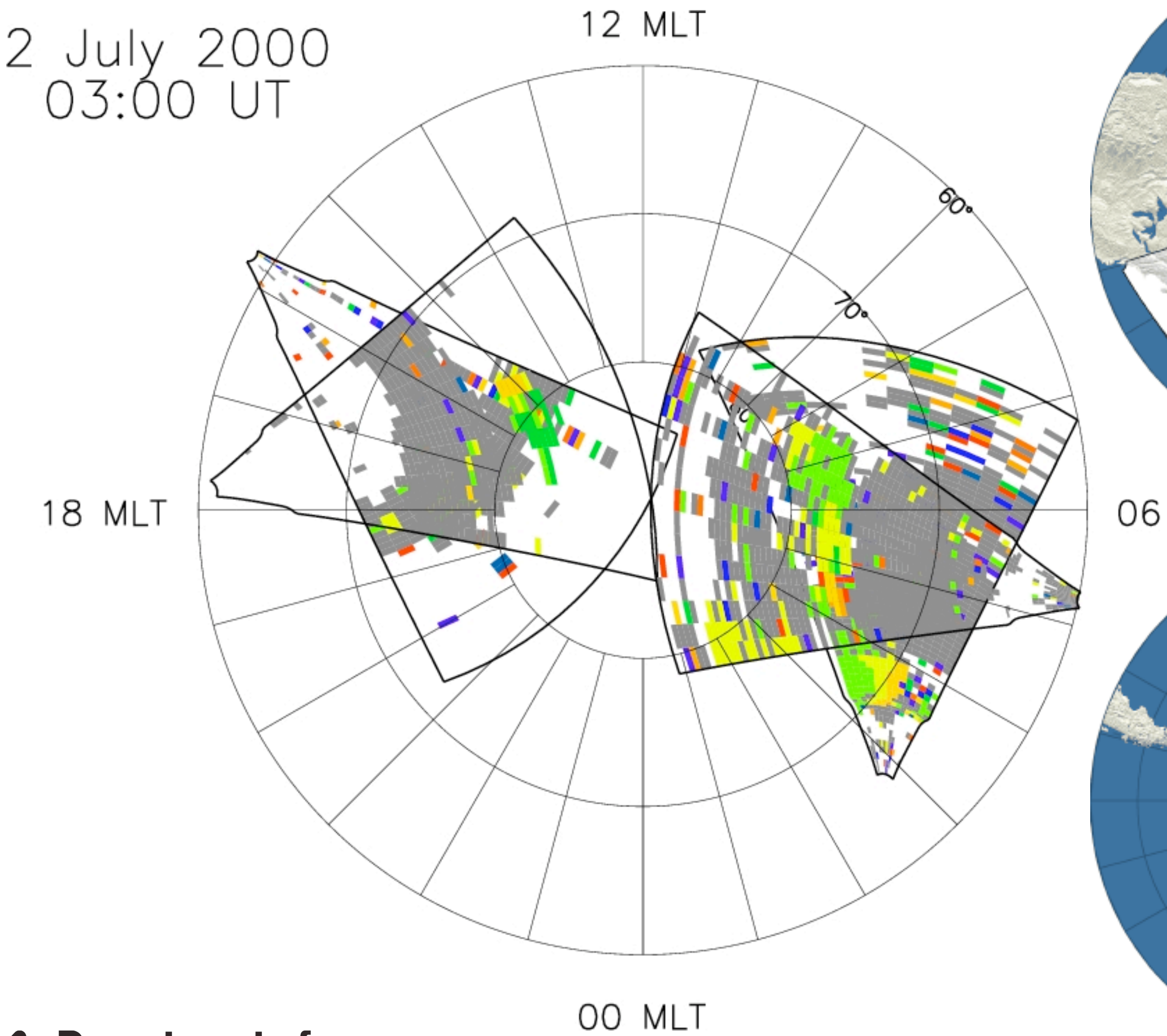

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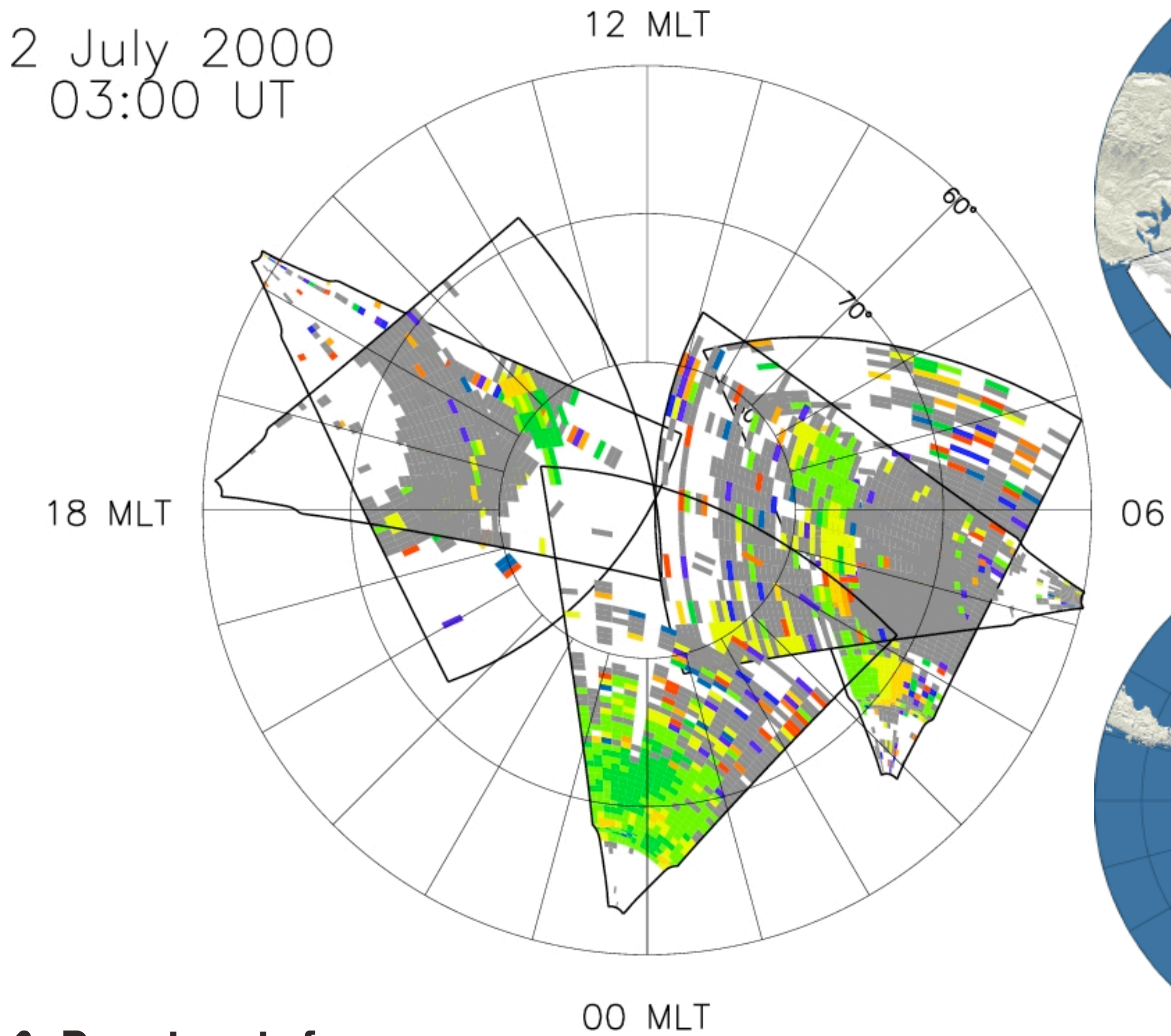

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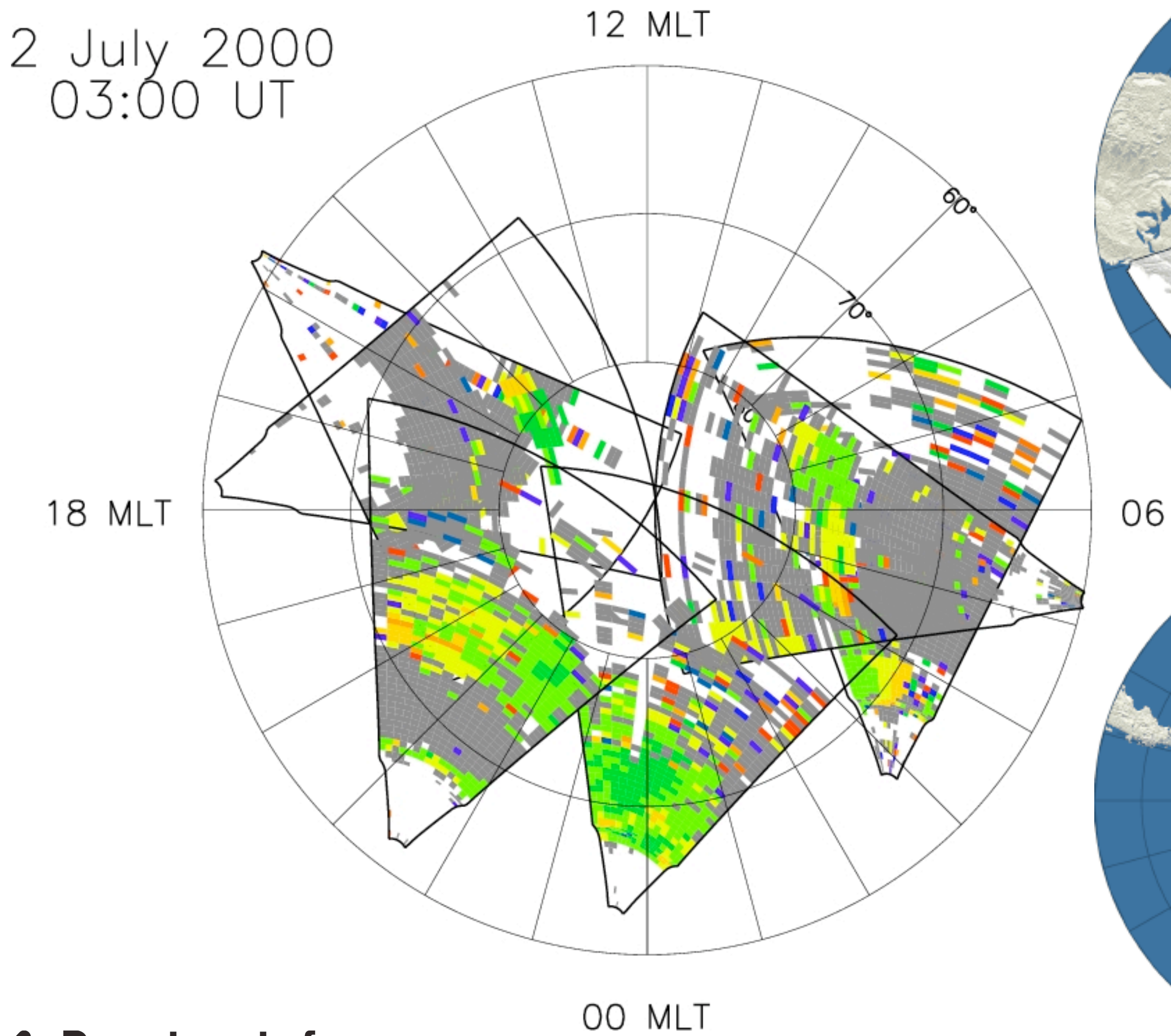

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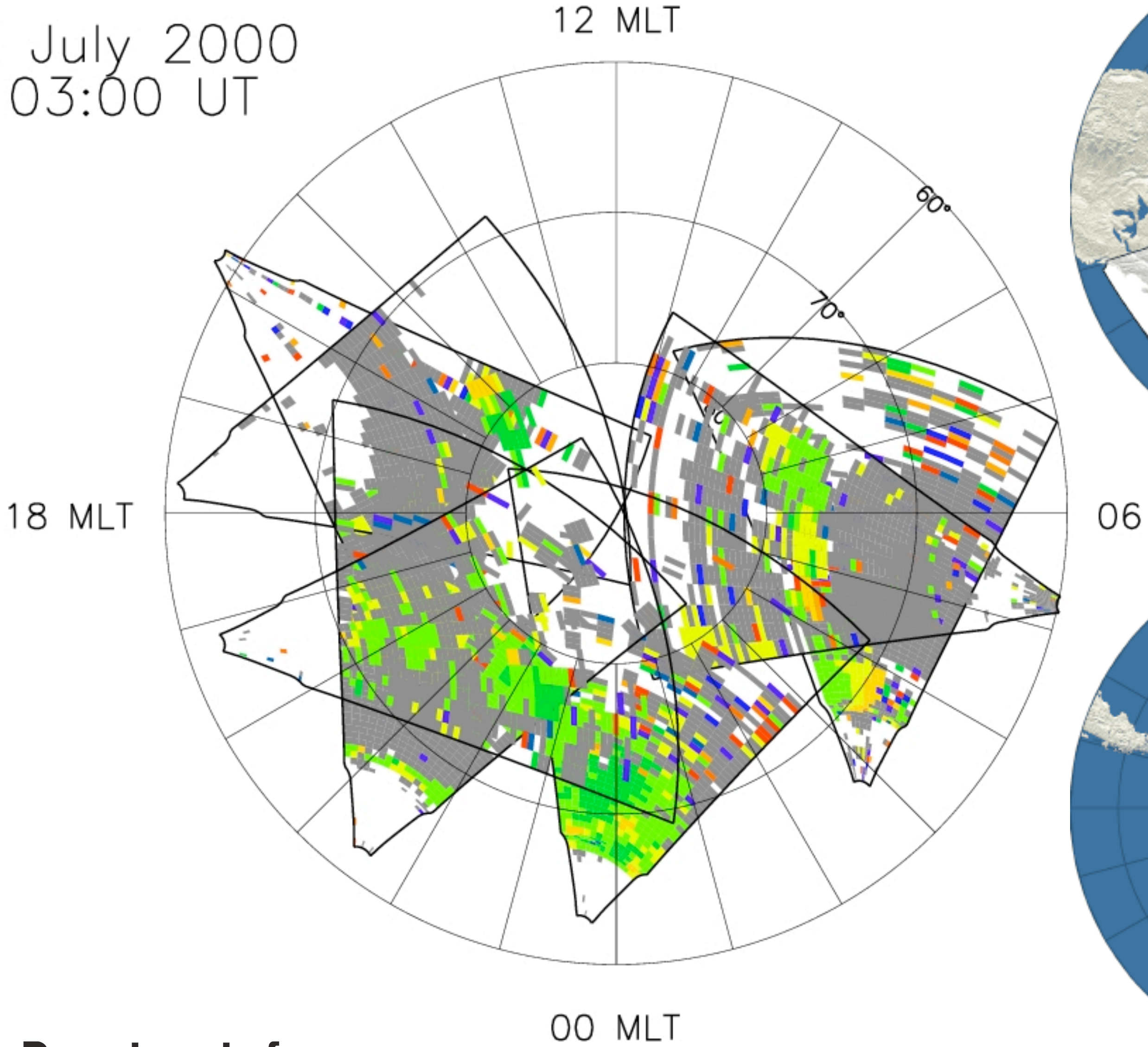

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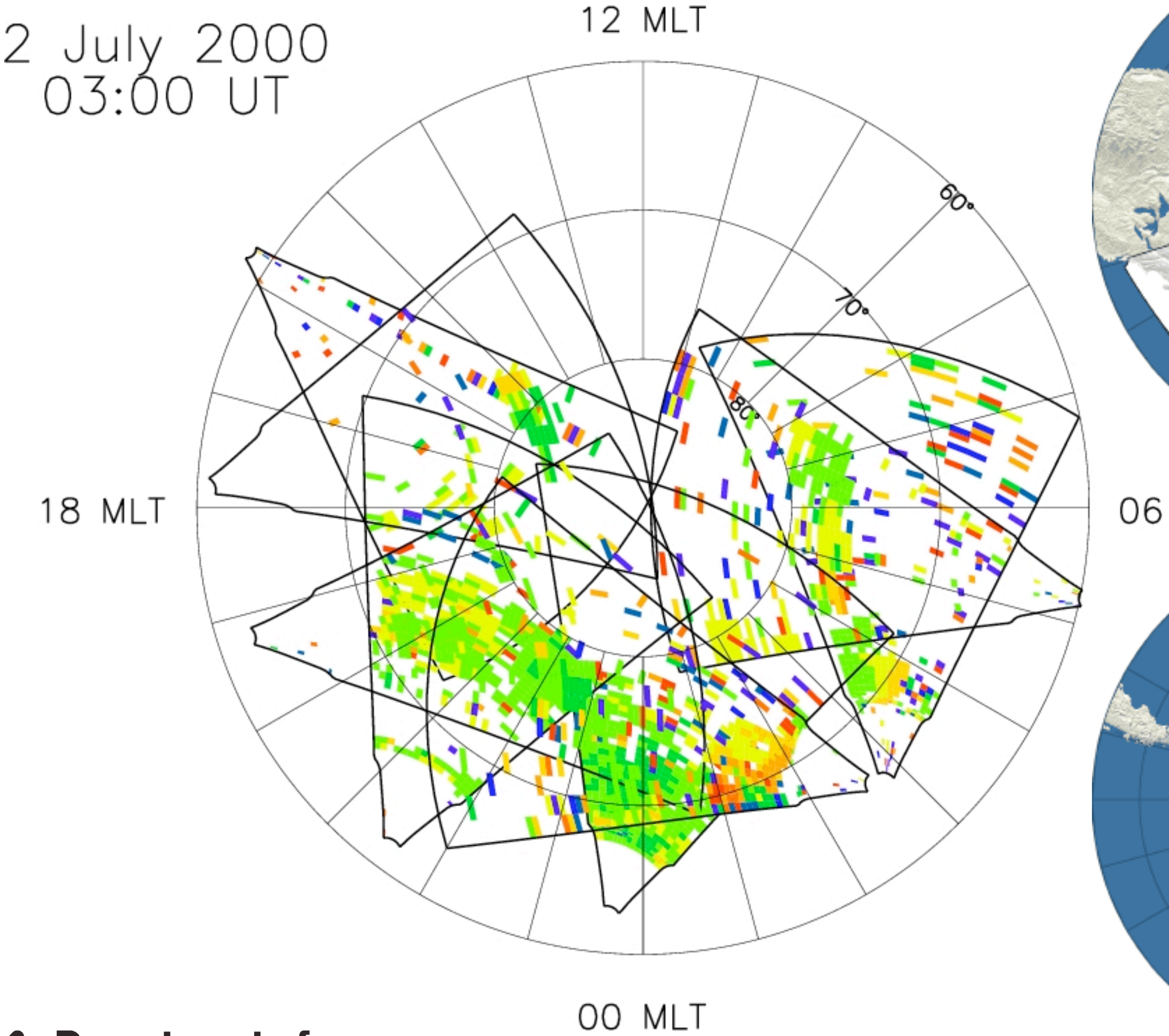

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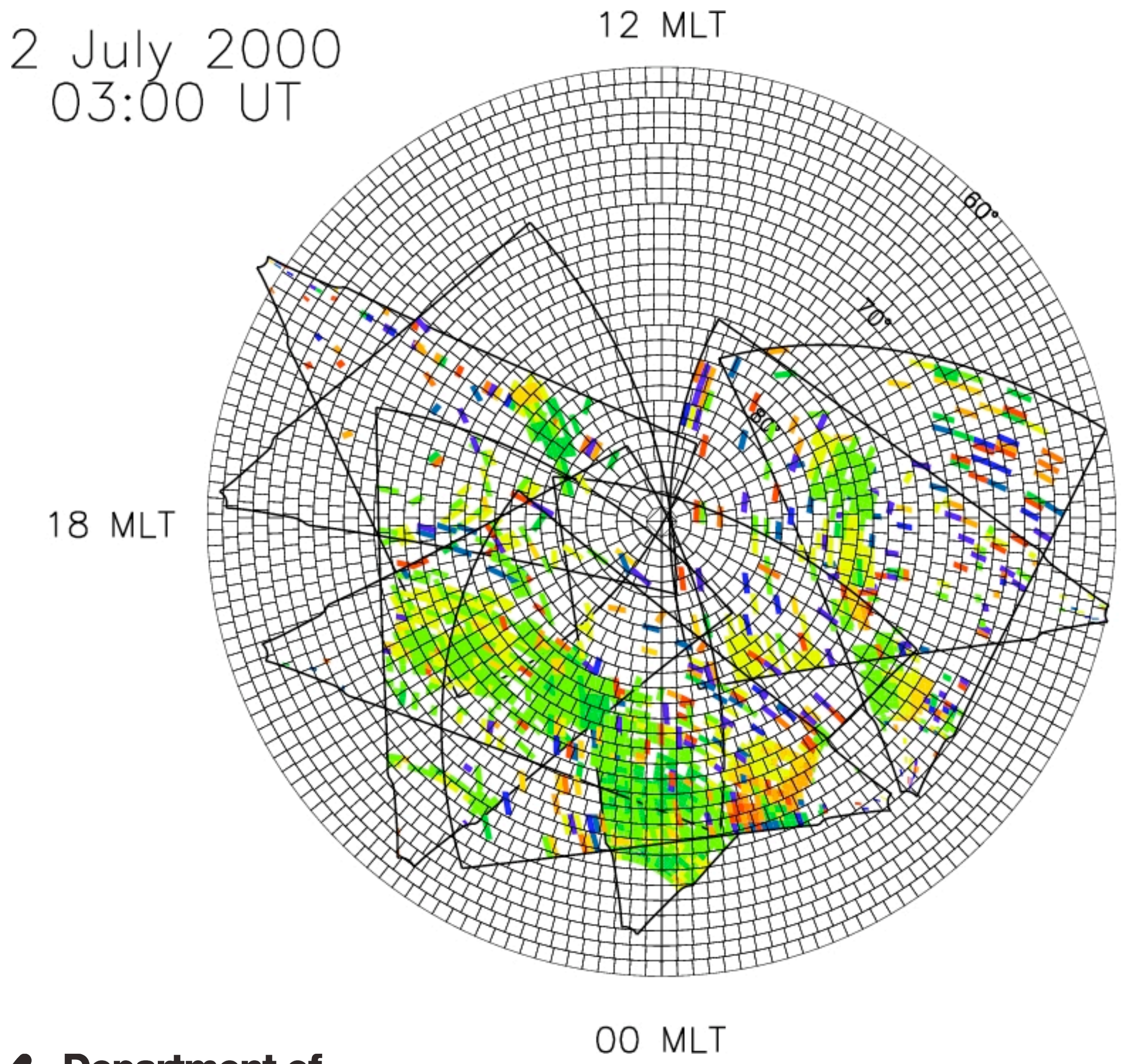

Data are gridded in cells

- 1° in latitude (≈111 km)
- ≈111 km longitude

Same as SuperDARN "potential-mapping" technique

Gridded data span 2 min intervals ±90 min from onset

No spatial averaging

No temporal averaging

Ground scatter excluded

Noise removed

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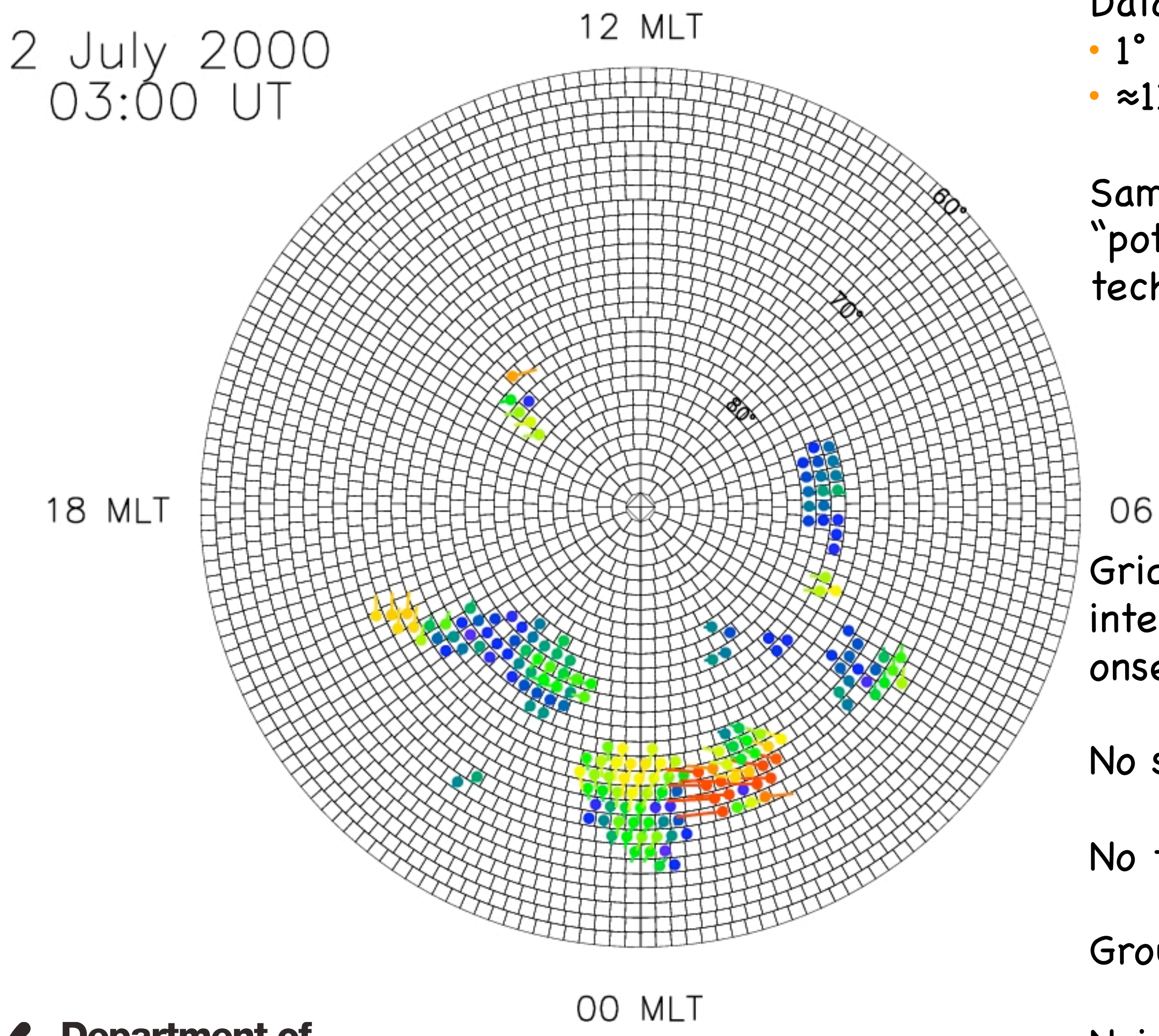

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Same as SuperDARN "potential-mapping" technique

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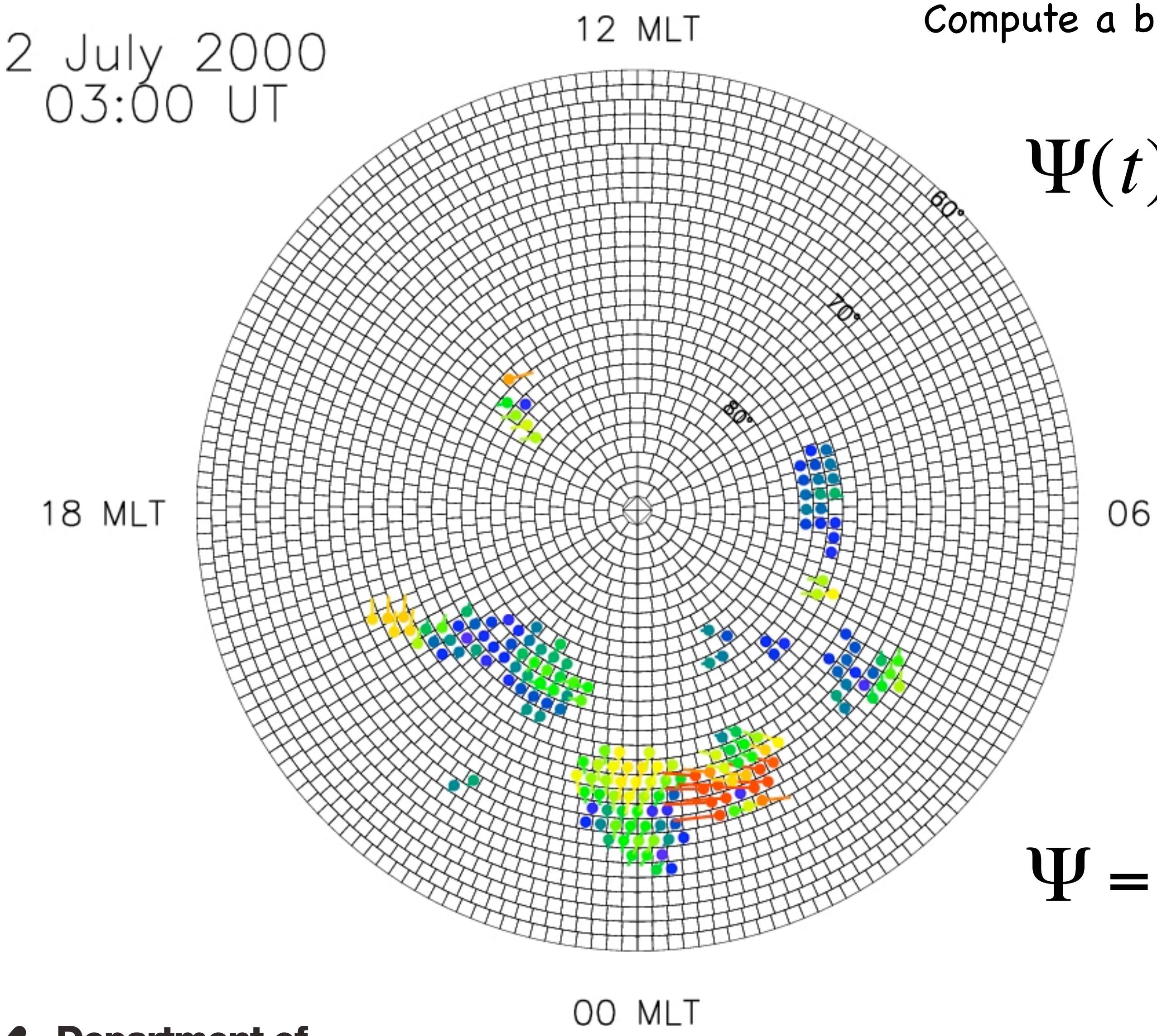
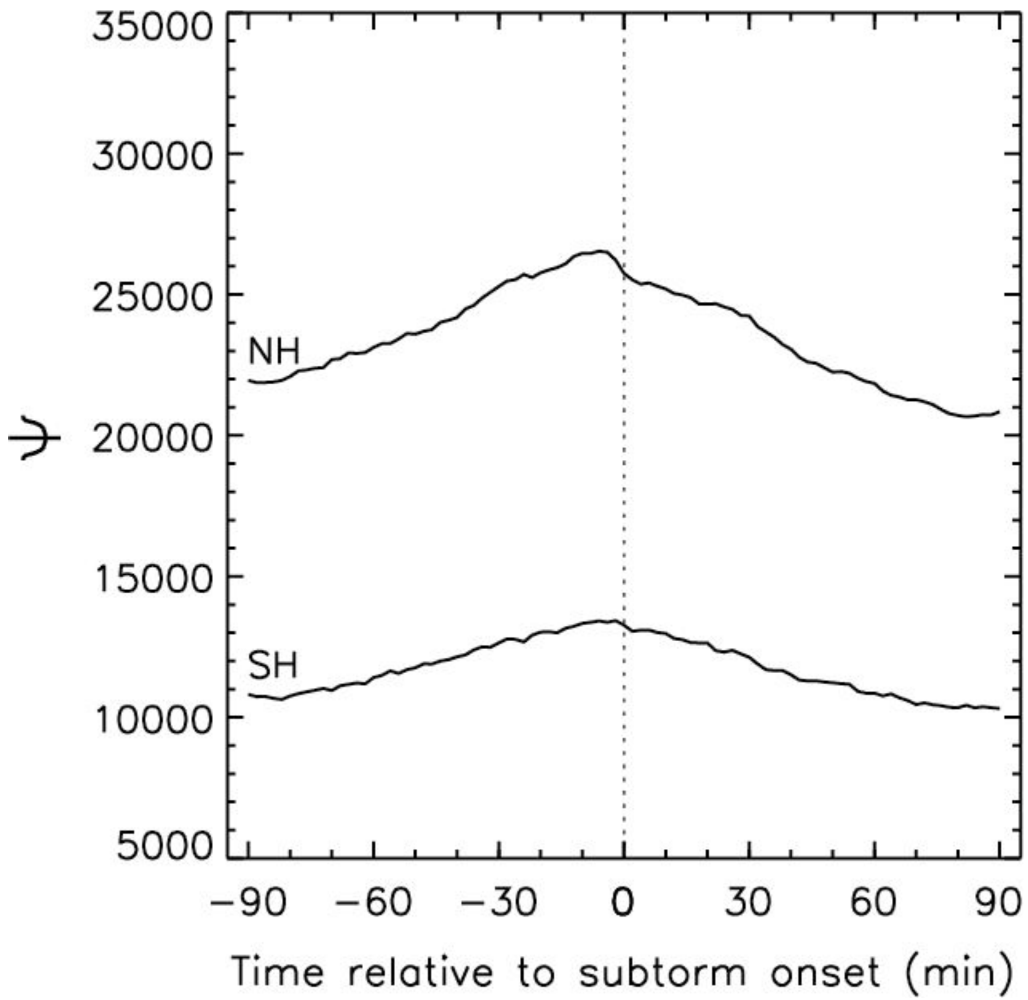
Compute a backscatter parameter:

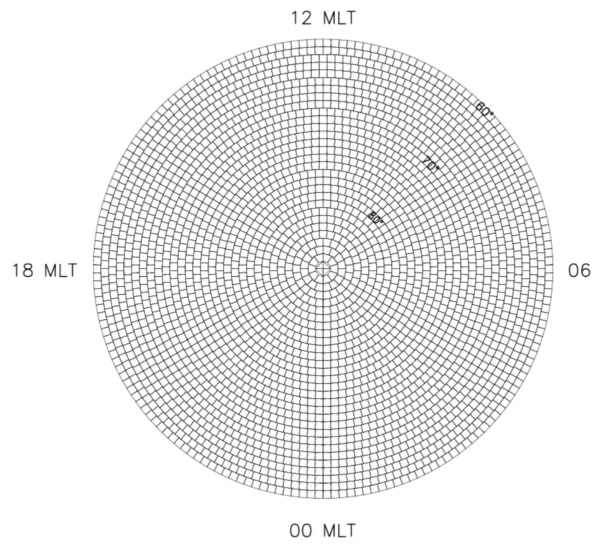
$$\Psi(t) = \frac{n_{scatter}(t)}{n_{radars}(t)}$$



$$\Psi = \frac{181}{7} = 25.86$$

BACKSCATTER VARIATIONS DURING SUBSTORMS





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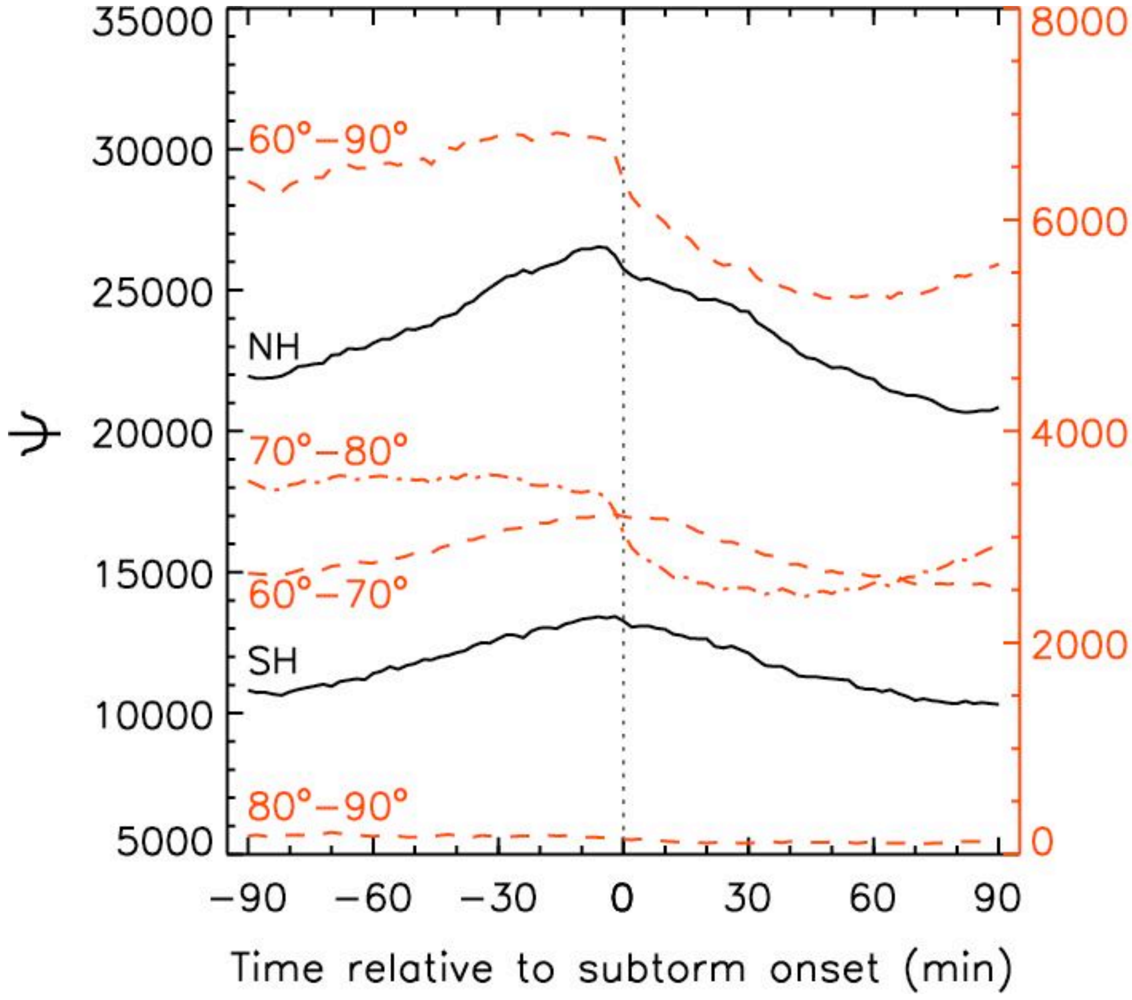
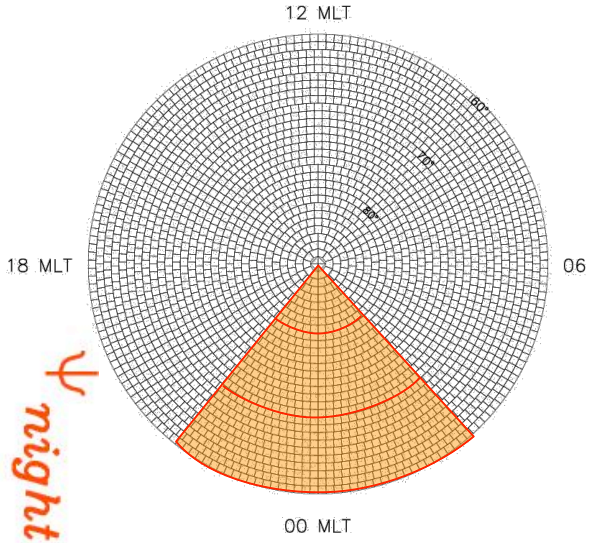
BACKSCATTER VARIATIONS DURING SUBSTORMS





$$\Psi(t) = \frac{n_{scatter}(t)}{n_{radars}(t)}$$

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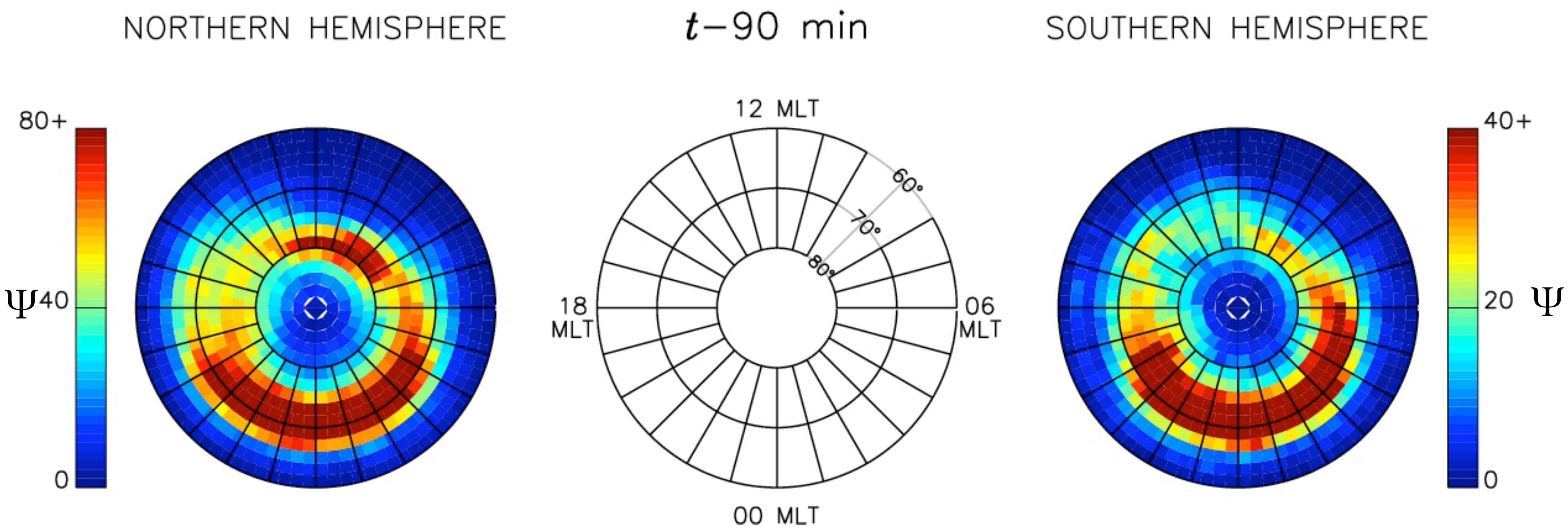
SPATIAL BACKSCATTER VARIATIONS



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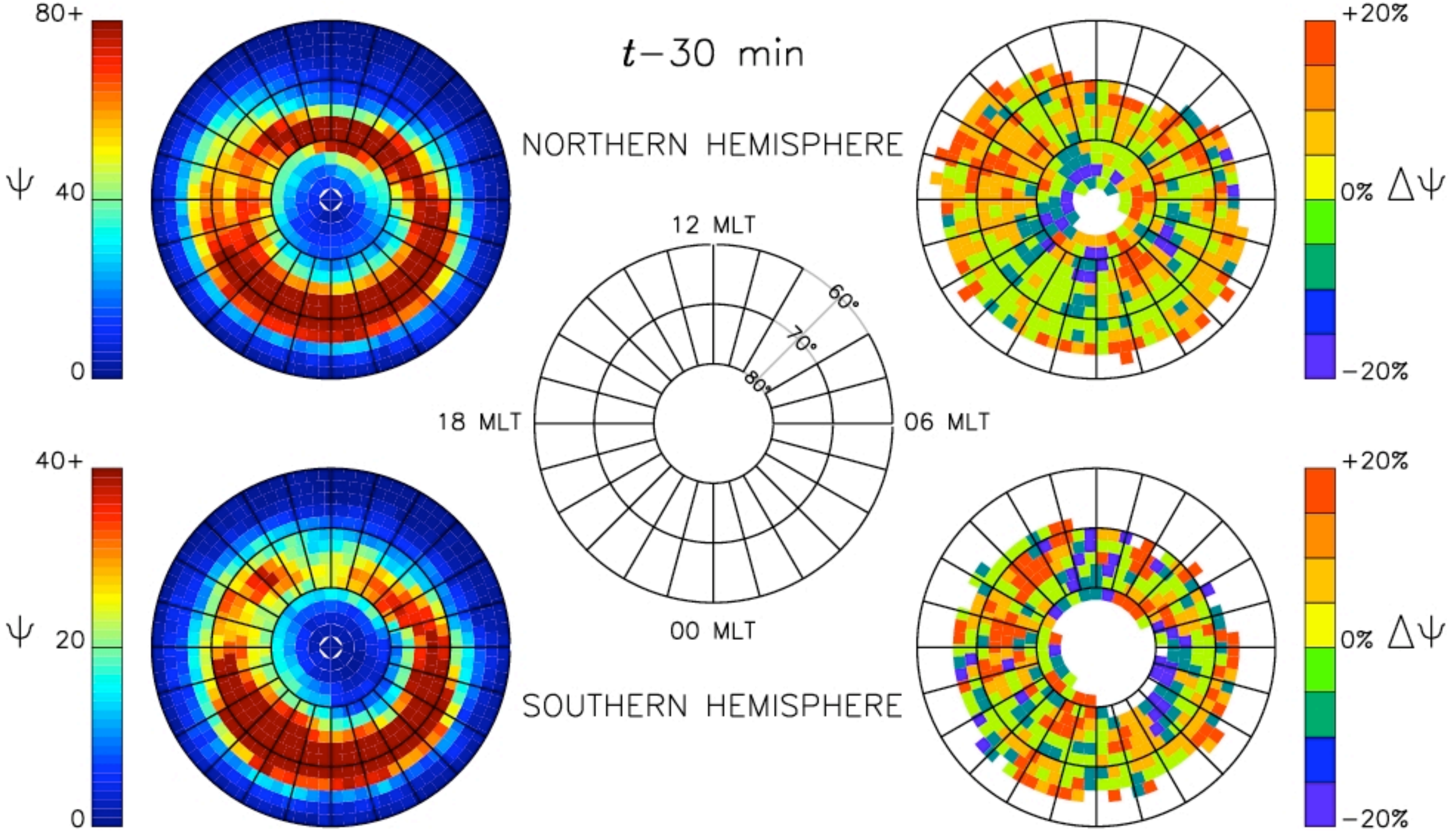

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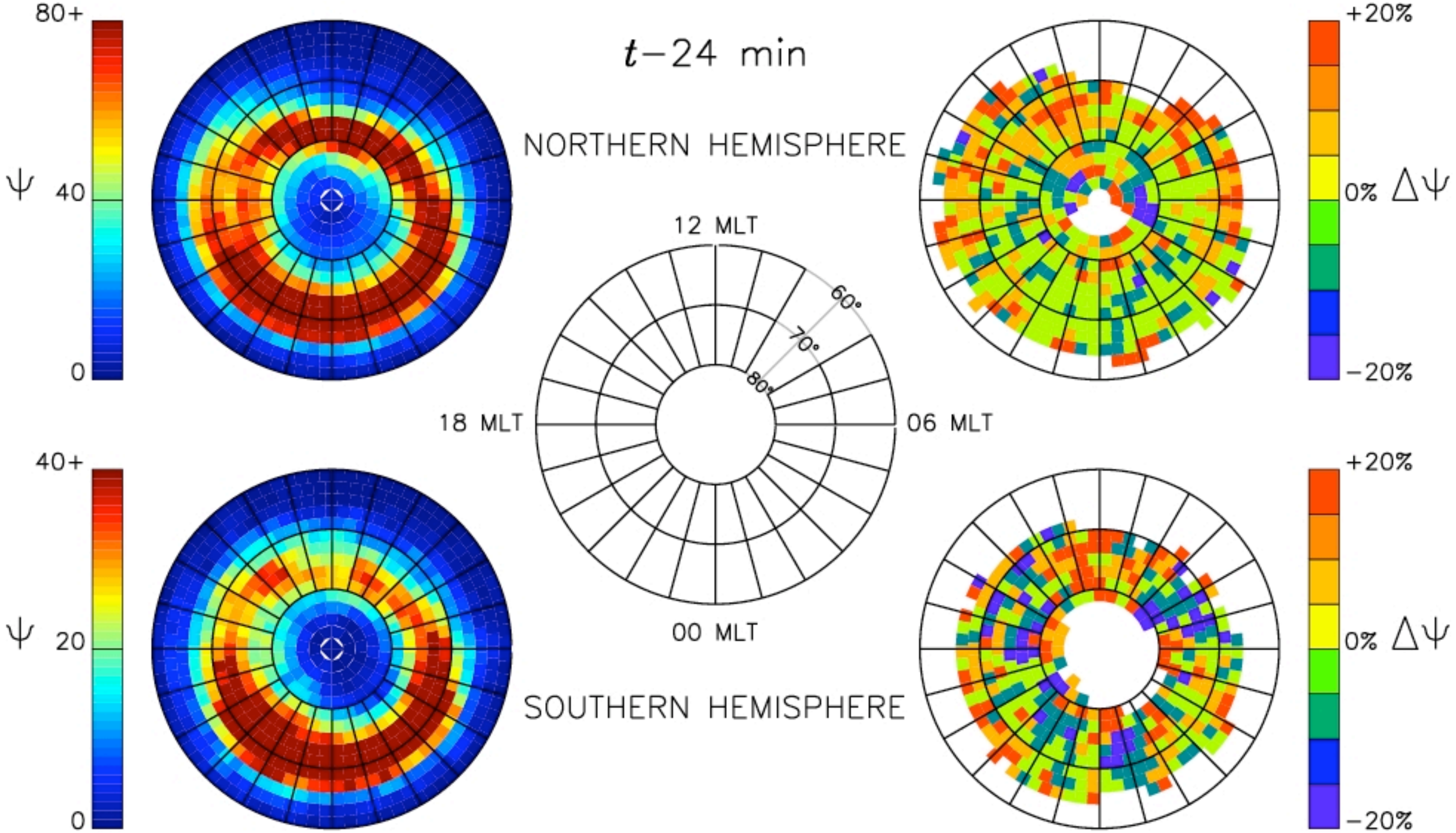

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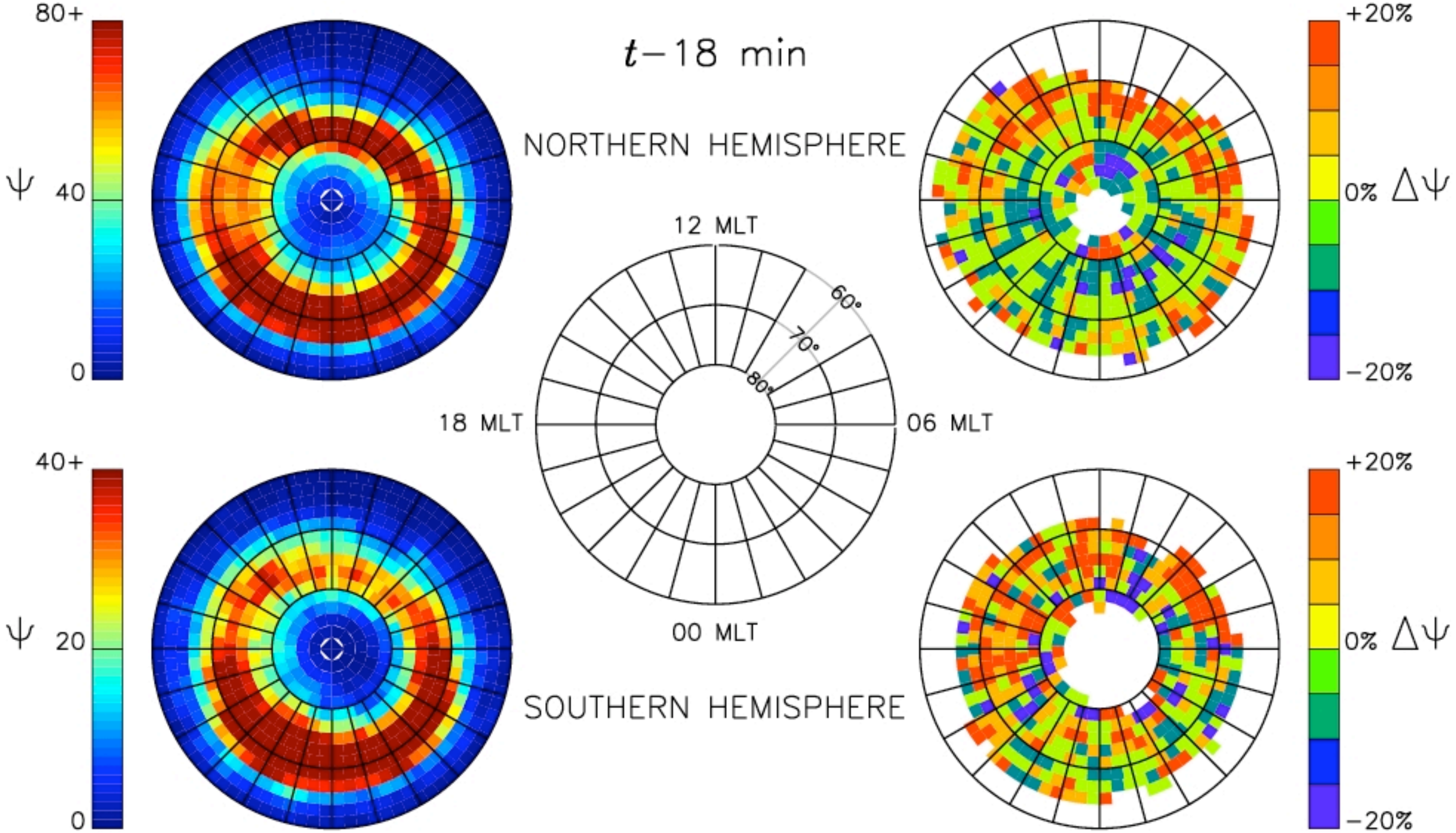

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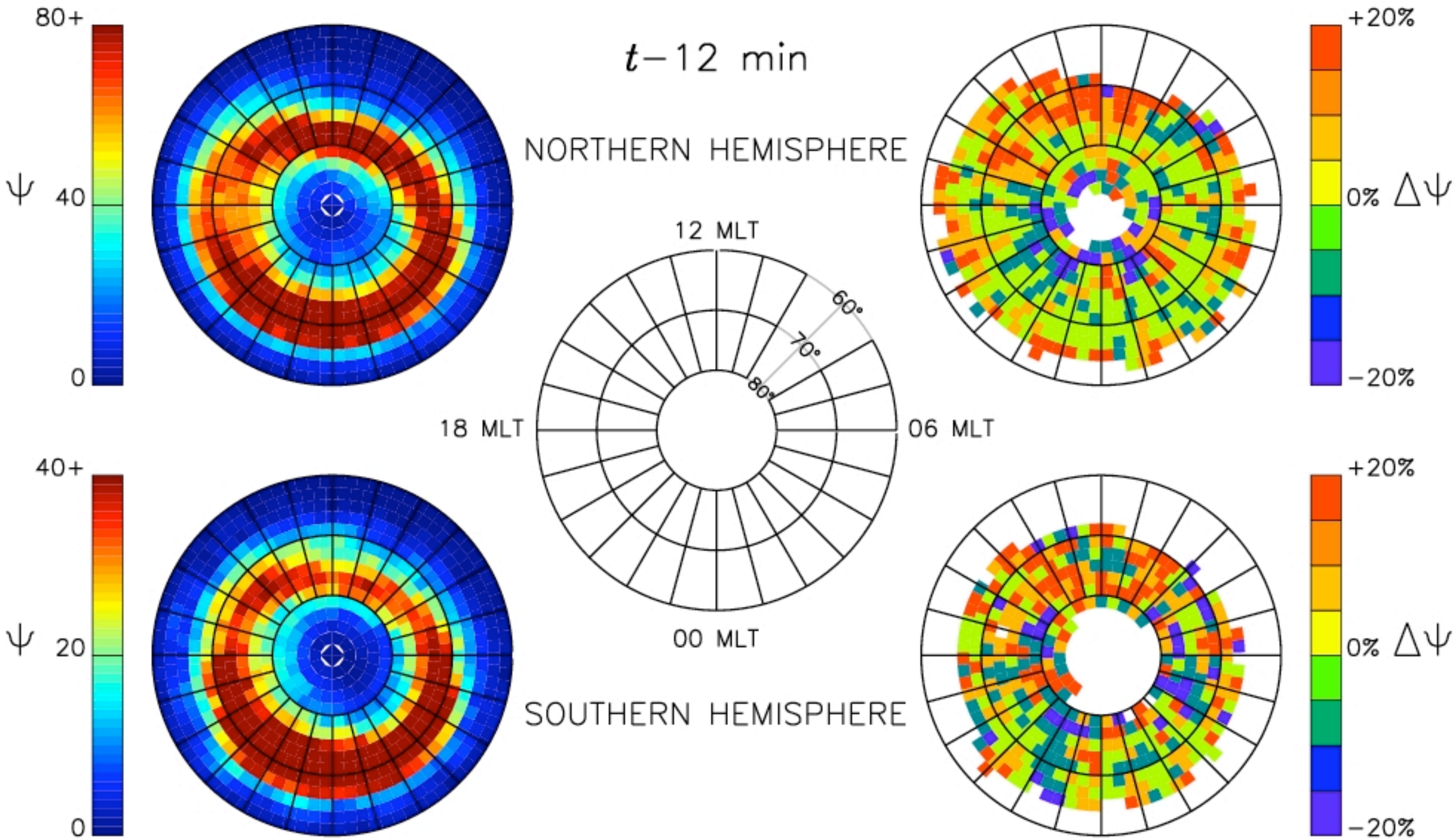
SPATIAL BACKSCATTER VARIATIONS



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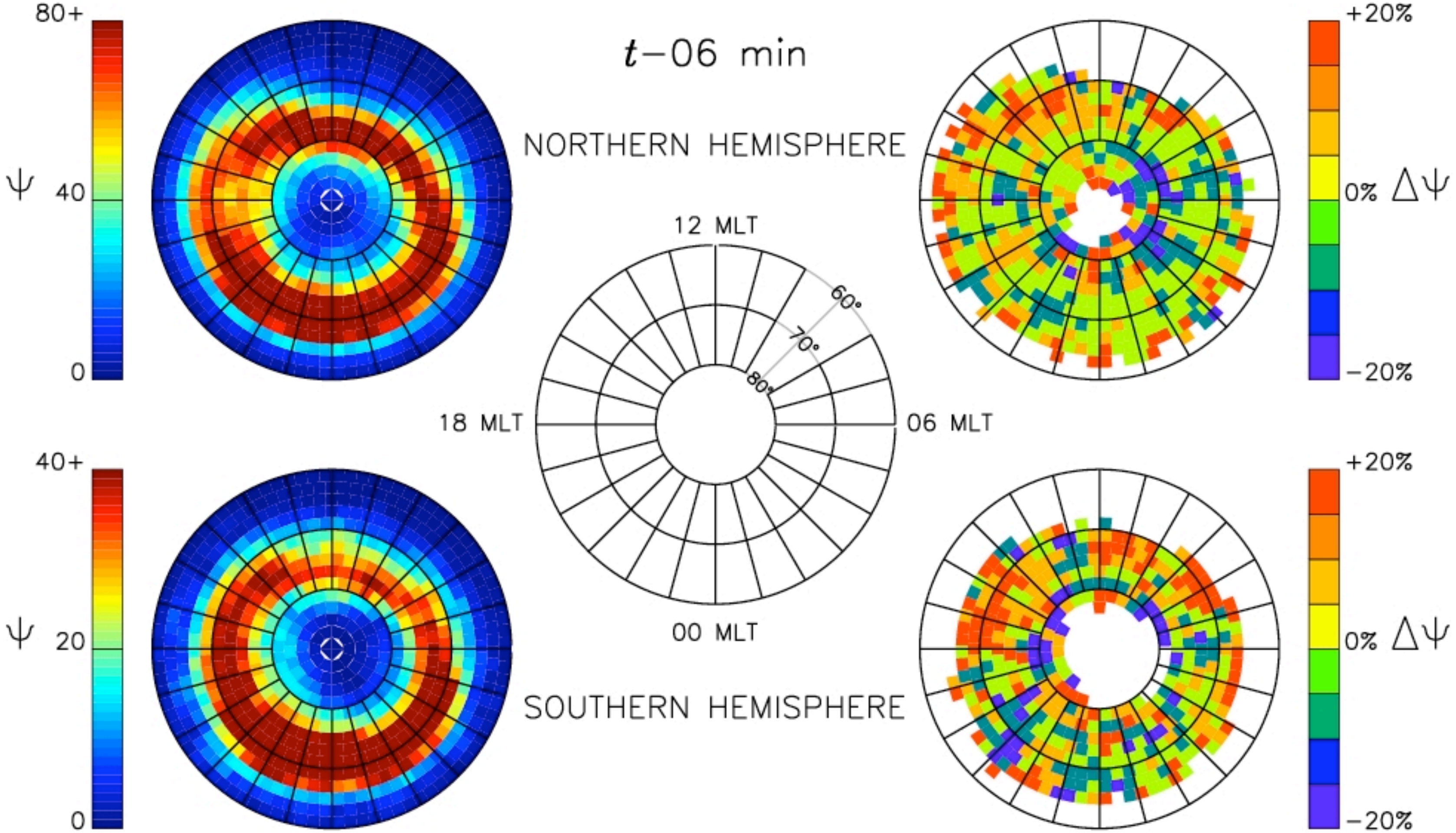

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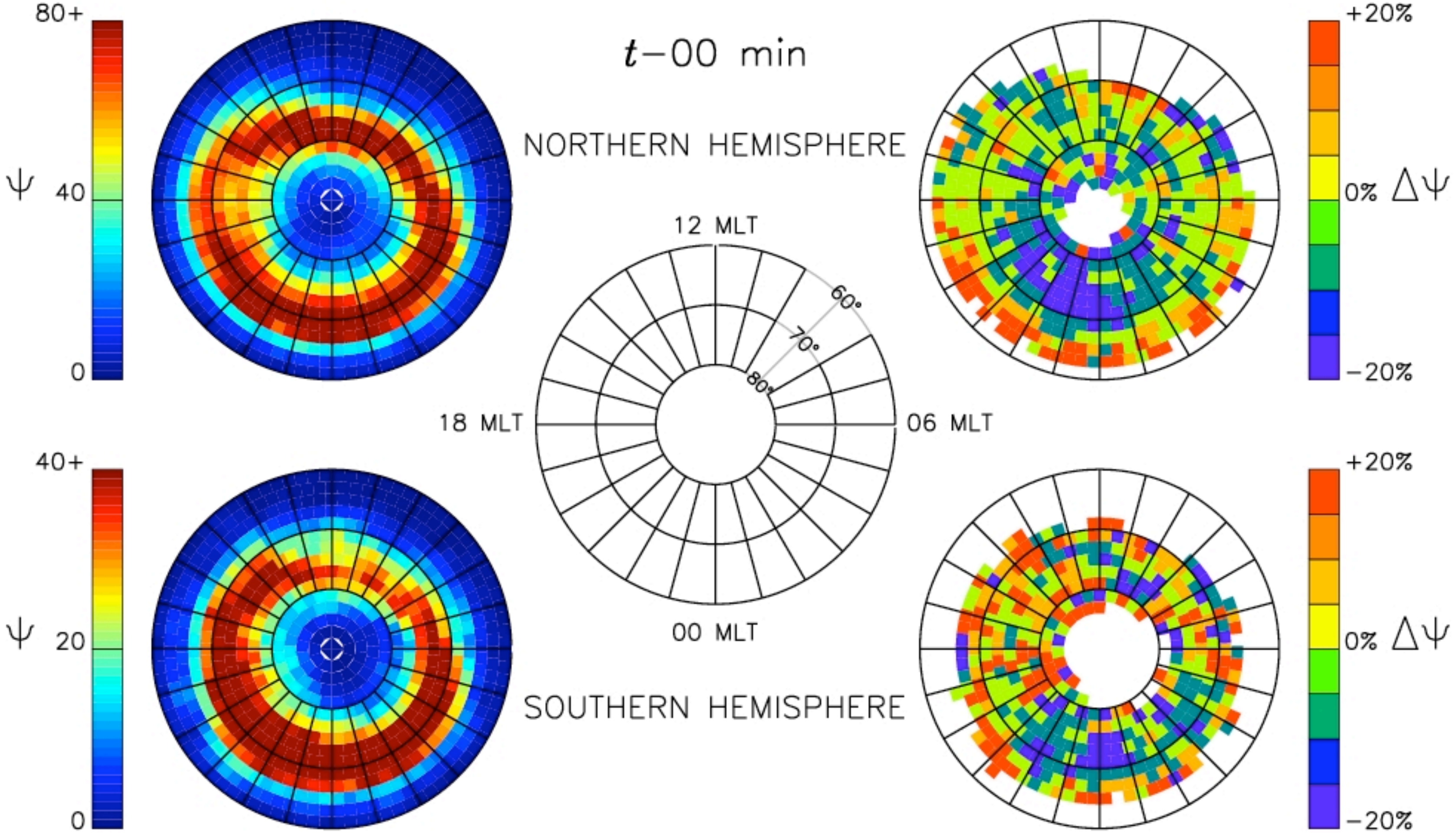

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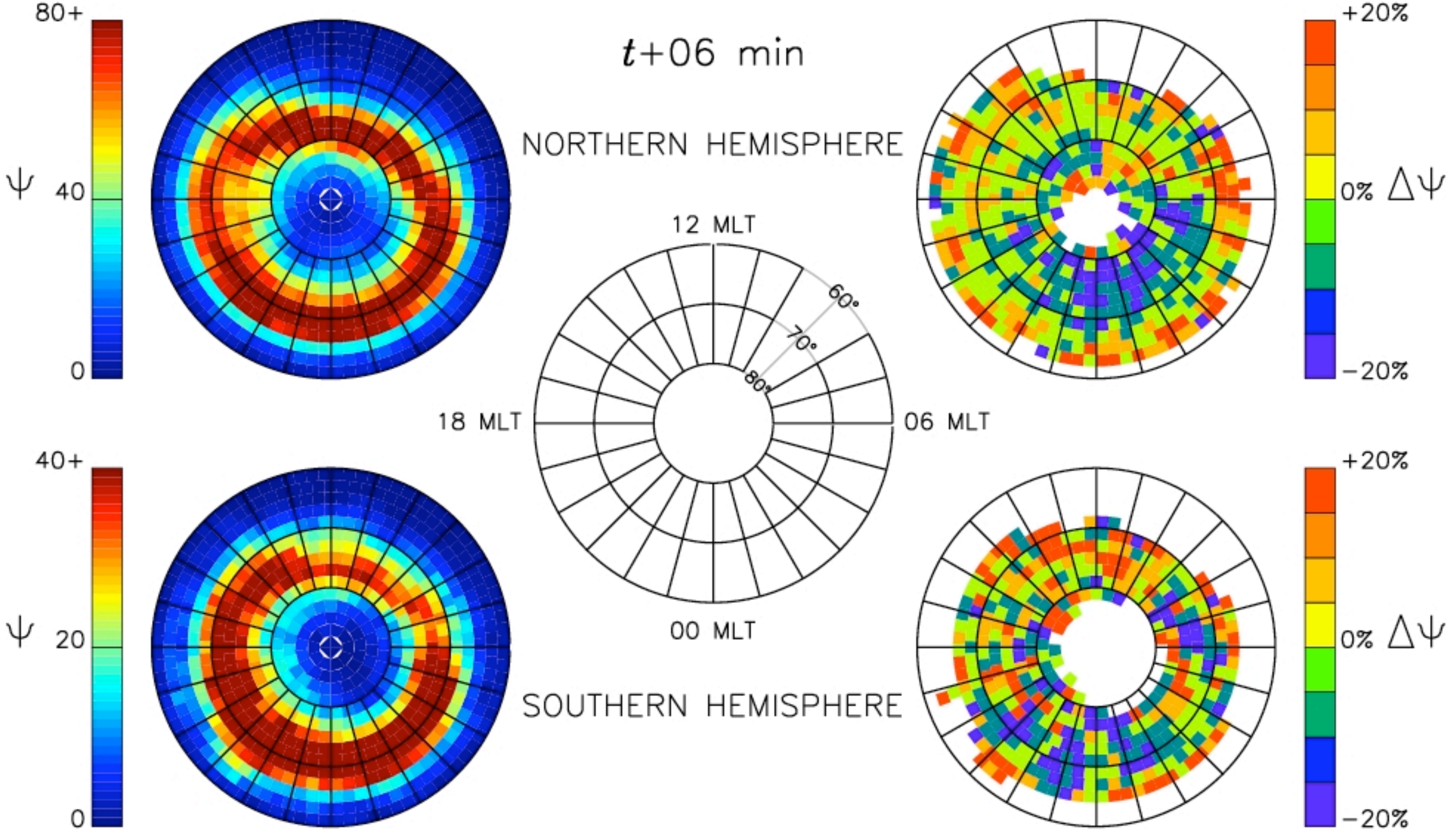

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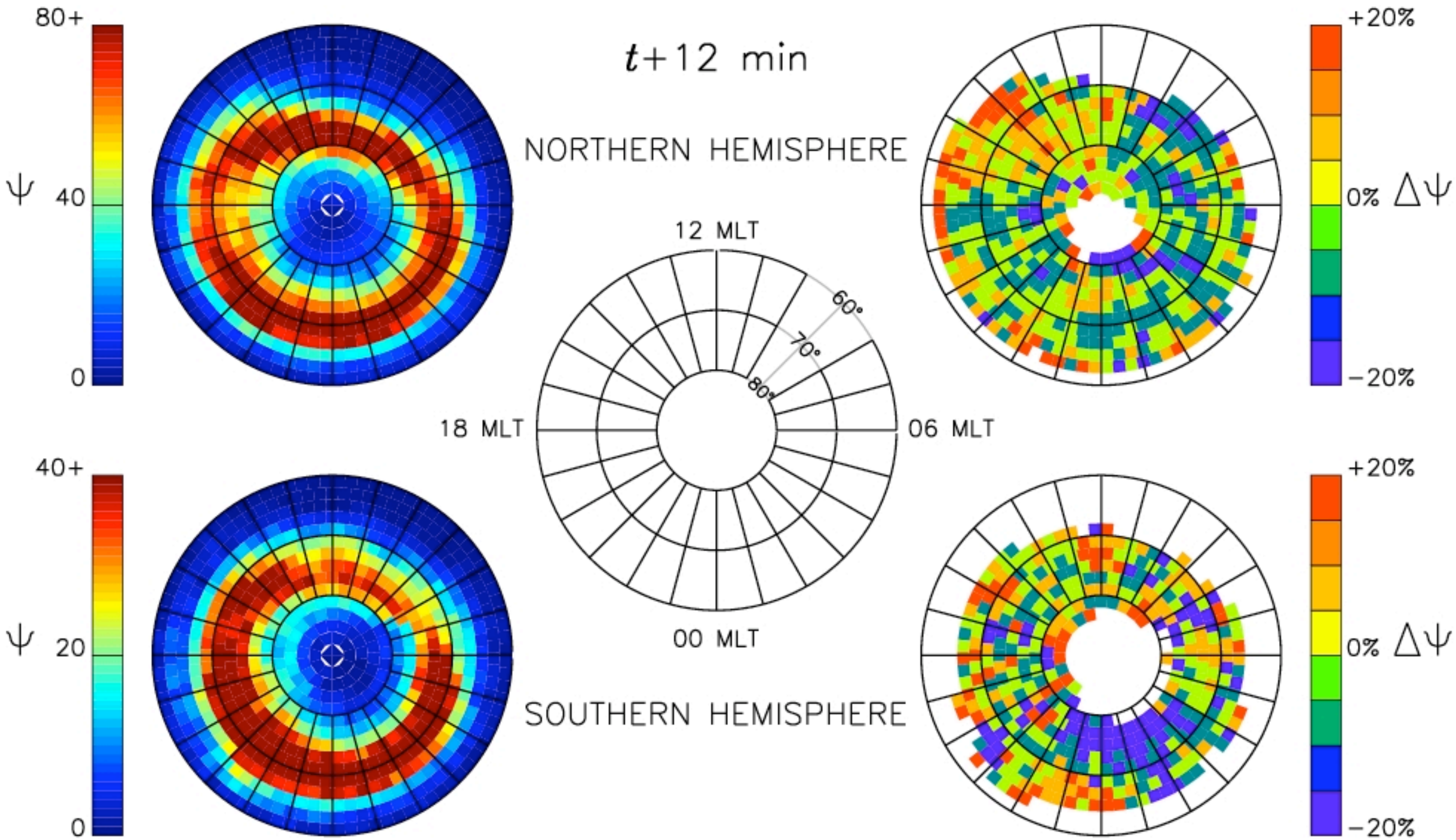

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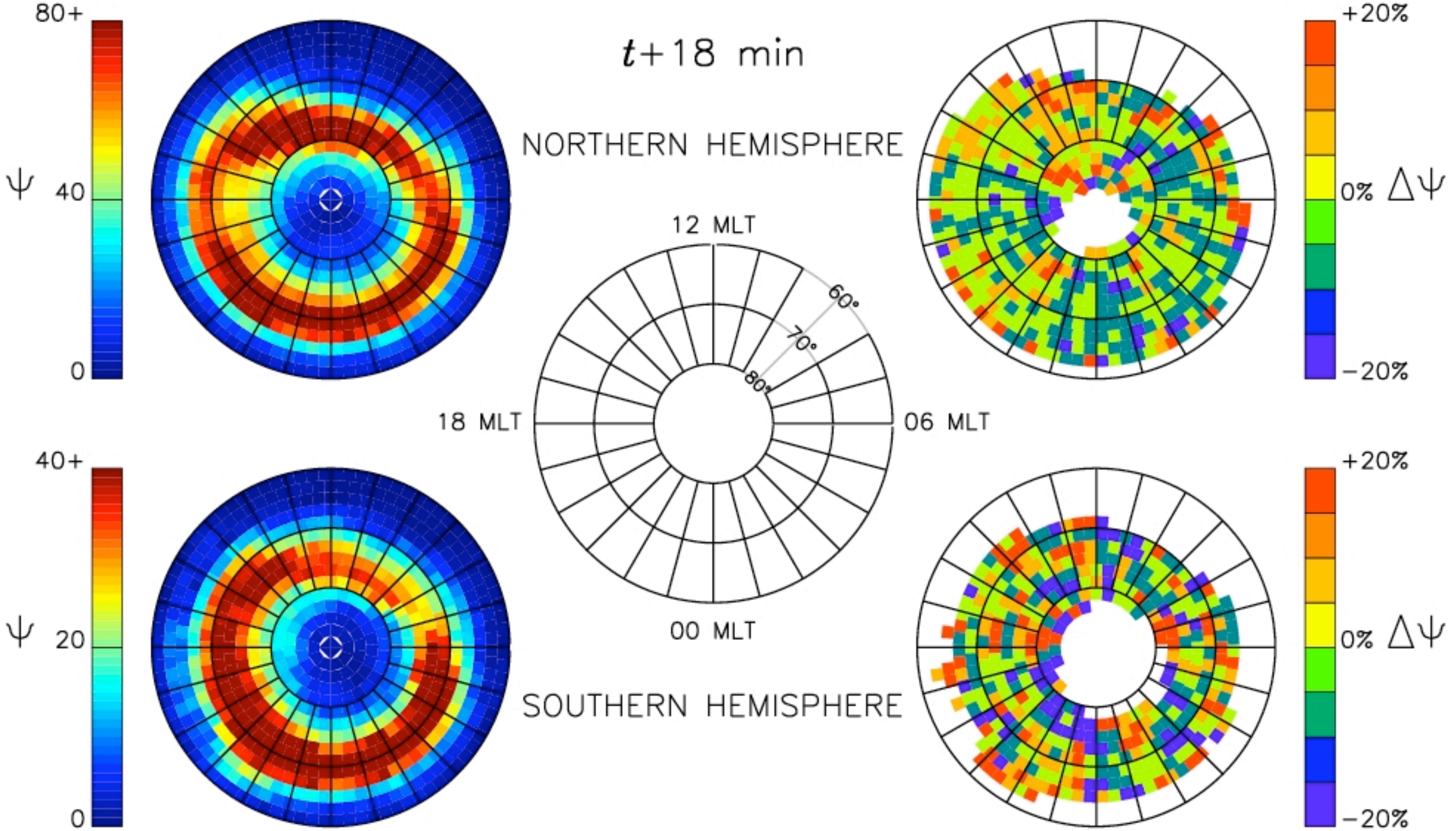

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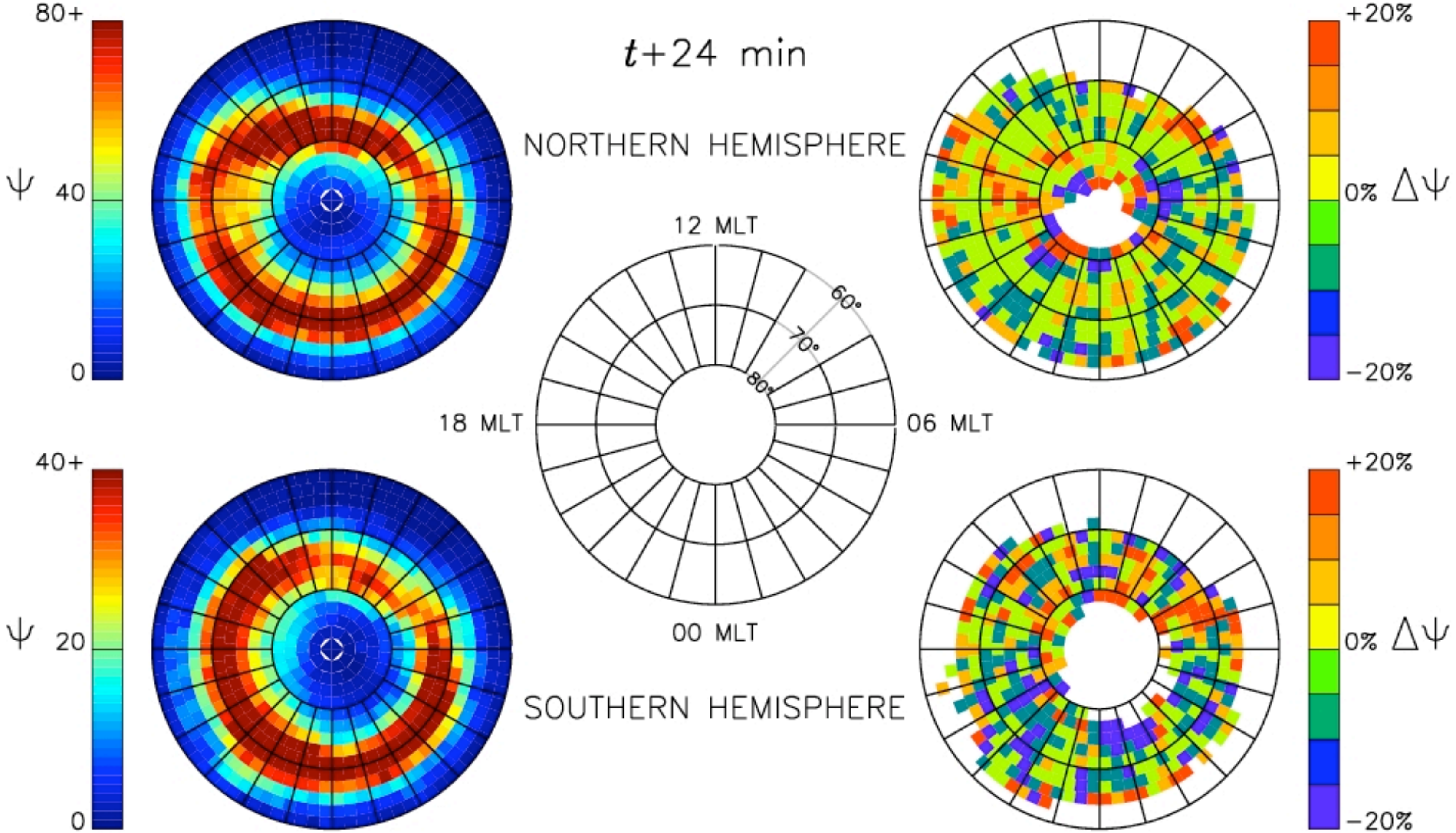

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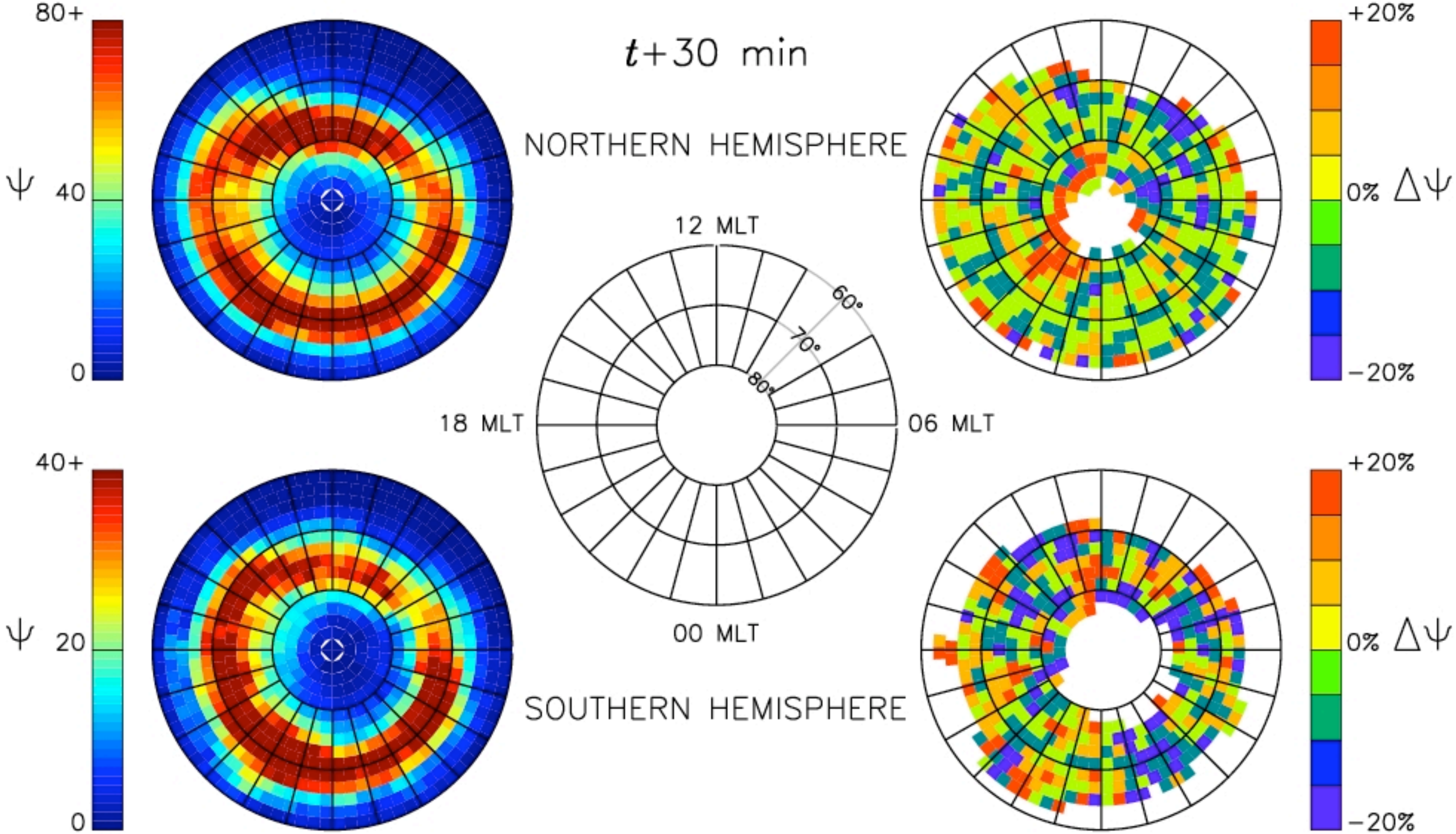

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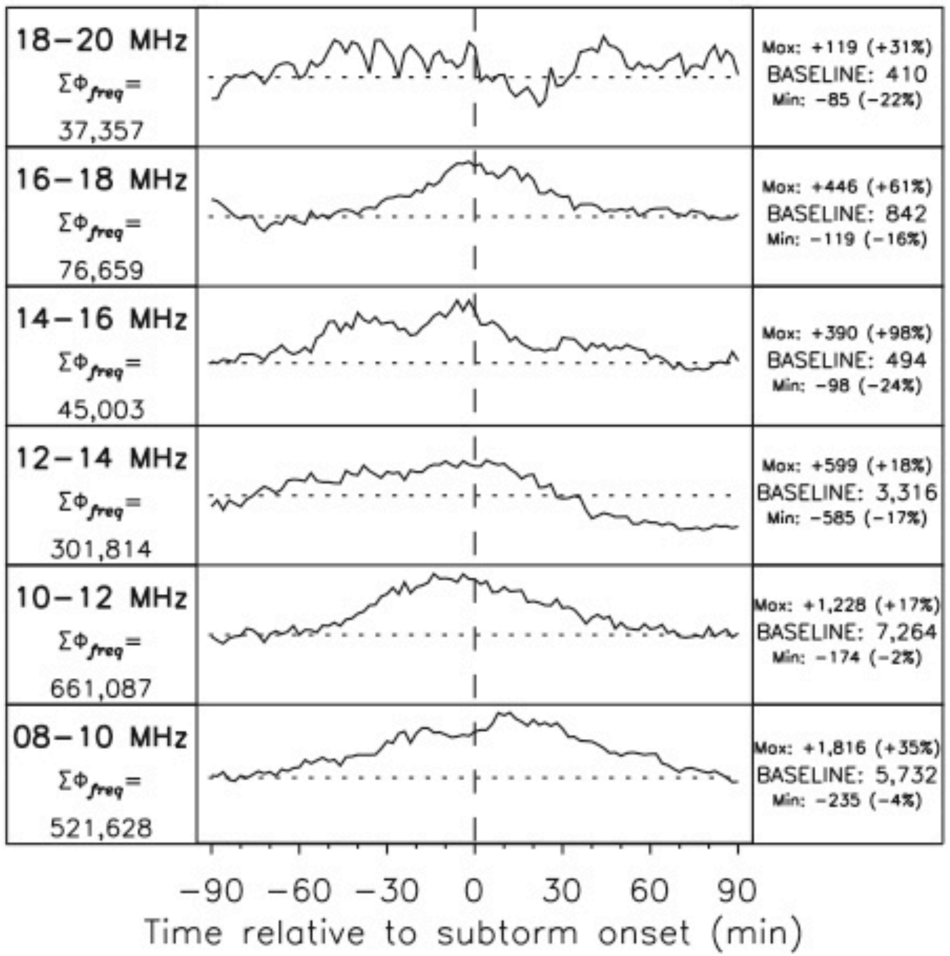
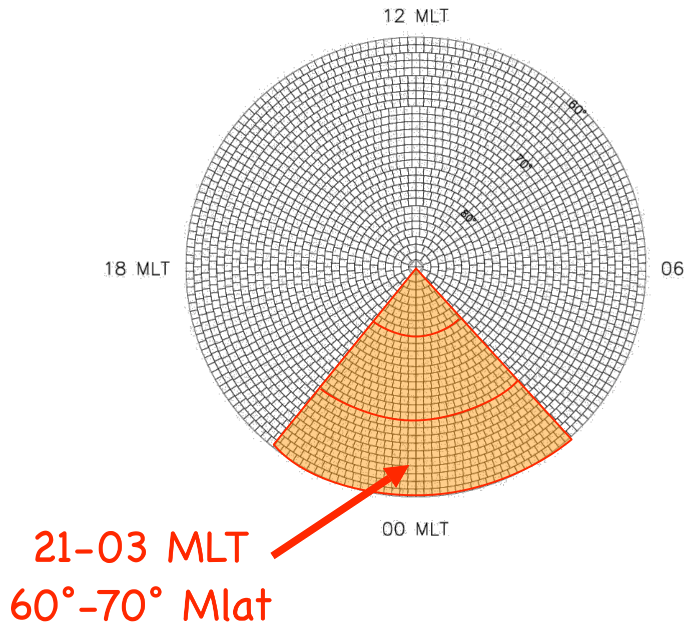
BACKSCATTER-FREQUENCY BEHAVIOUR





$$\Psi(t,\nu) = \frac{n_{scatter}(t,\nu)}{n_{radars}(t,\nu)}$$

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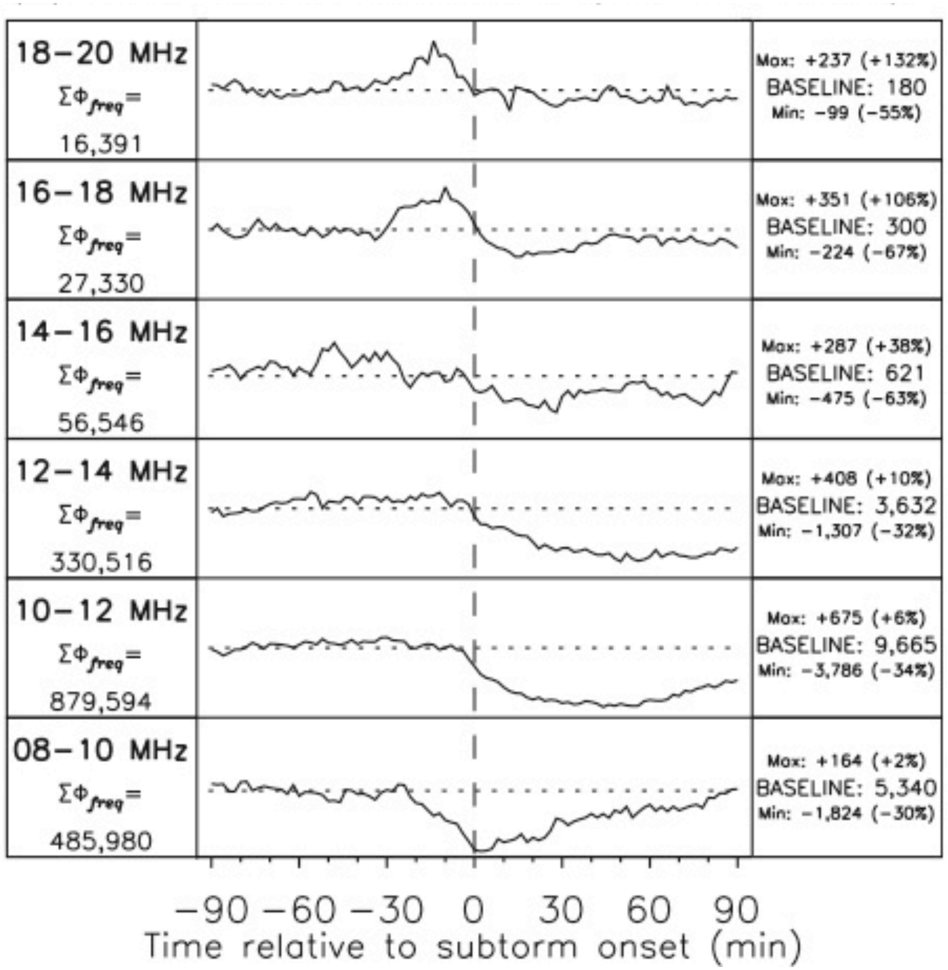
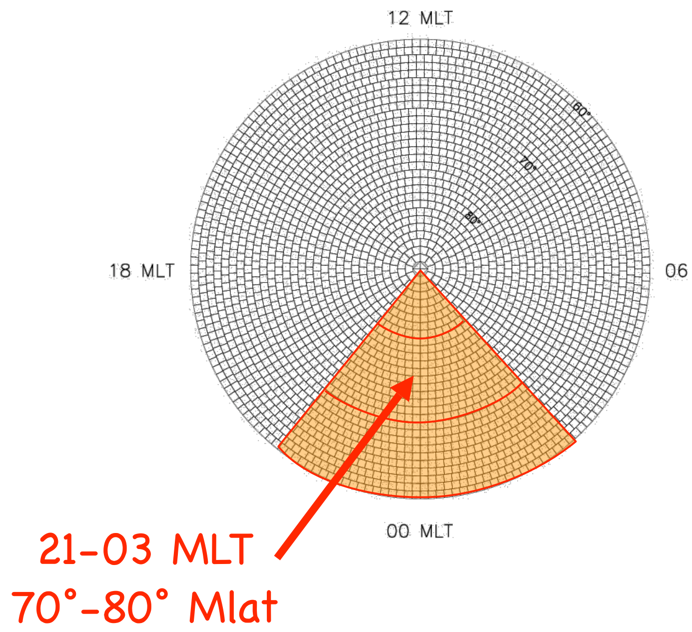
BACKSCATTER-FREQUENCY BEHAVIOUR





$$\Psi(t,\nu) = \frac{n_{scatter}(t,\nu)}{n_{radars}(t,\nu)}$$

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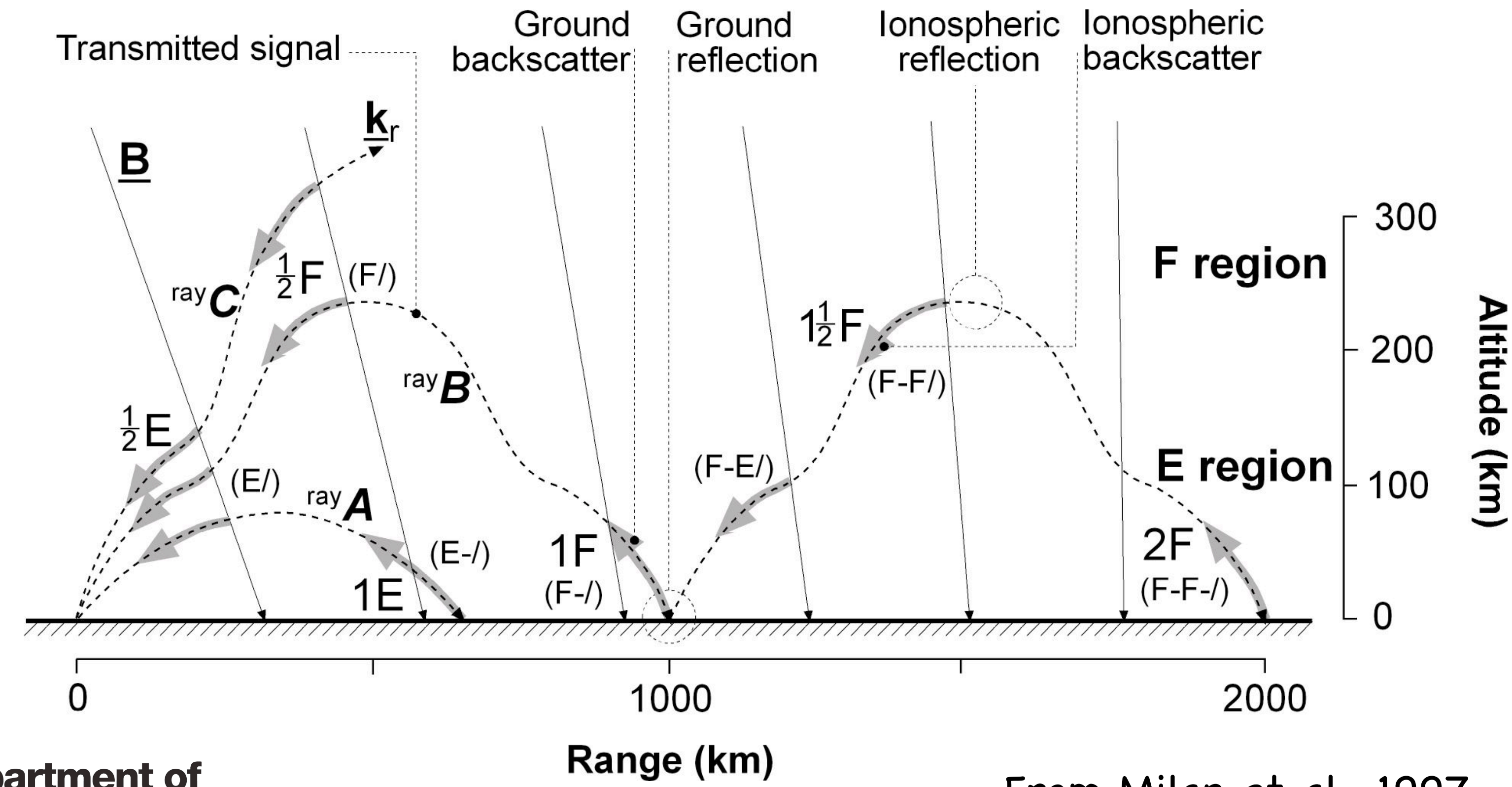
FINDINGS

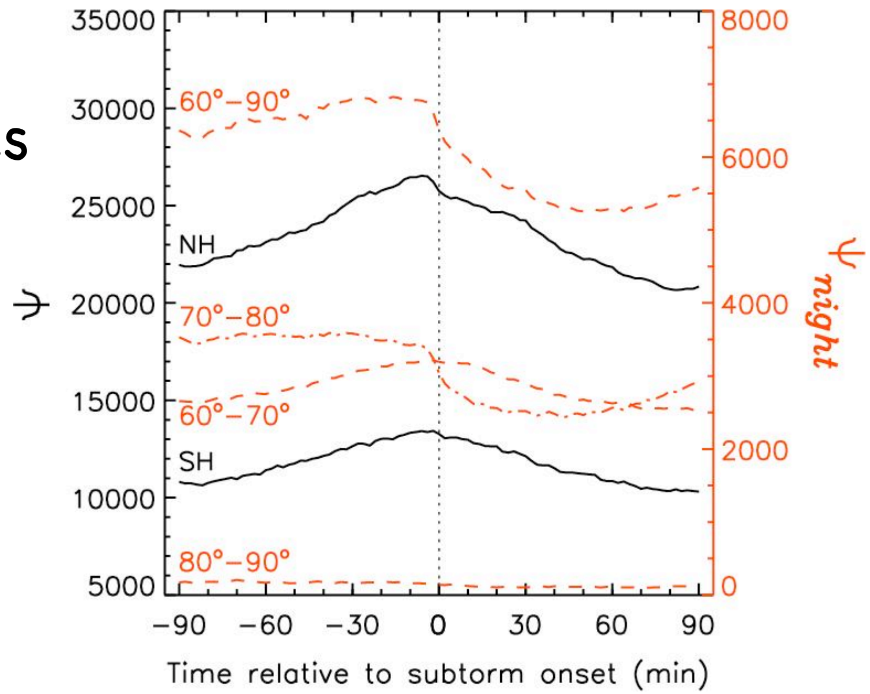
- NH radars observe approx twice as much backscatter as SH radar



From Milan et al., 1997.

FINDINGS

- Globally, the amount of backscatter observed by SuperDARN peaks a few minutes prior to expansion phase onset
- In the nightside ionosphere:
  - Scatter falls overall
  - Reduction at 70°- 80° Mlat
  - Increases in at 60° - 70° Mlat
  - Equatorward motion of backscatter



- Possible to use "stereo" developments of SuperDARN system to maximise scatter at different latitudes?

FUTURE DEVELOPMENTS

- **This work published recently**

  "The Influence of Magnetospheric Substorms on SuperDARN Radar Backscatter"

  Wild & Grocott, JGR, 2008.

- **Follow on work looking at flows**

  "The influence of Magnetospheric Substorms on High-Latitude Ionospheric Convection"

  Grocott, Wild, Milan & Yeoman

  - Poster presented at this meeting
  - Submission expected shortly

- **Coming soon…**

  Large scale analysis of SuperDARN Doppler spectral width during these 3005 substorms and comparison with IMAGE WIC optical data.

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