"Rates of occurrence of TIGER HF radar echo parameters sorted according to the K_p index and the IMF - early results"

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Why Compile TIGER Echo Statistics?

- **The operational capability of the radar needs to be defined to help in the design of new experiments.**
- **Geographically, TIGER is the most equatorward of any of the SuperDARN radars (43.4°S, 147.2°E), yet it still scans the high geomagnetic latitude region (~57°S to 88°S).**
- **The statistical approach is [one of] the best ways to characterise the FITACF parameters and new phenomena discovered with any instrument.**

What Factors Condition the Observed Distributions of TIGER echoes?

(1) The Design and Operation of the Radar:

The power transmitted and the effective gain of the radar.
The radiation distribution patterns.
The chosen operating frequencies.

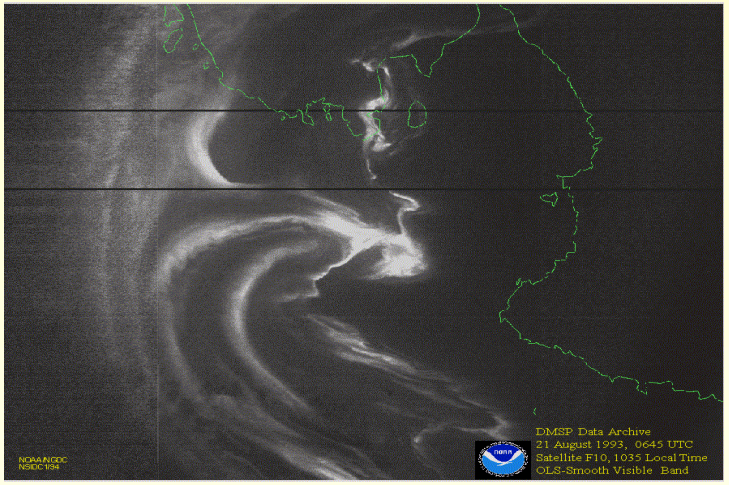
TIGER TX Box

(2) Radio Propagation Effects:

The morphology of the ionospheric layers and the propagation modes they support.
Convergence and divergence of the radio waves.
Nondeviative ionospheric absorption (diurnal, seasonal, and sunspot cycle variations).

(3) Irregularity Generation Mechanisms:

Decameter-scale ionospheric irregularities are thought to be generated by instability processes acting in the presence of gradients in electron density. These gradients might be controlled by:



The degree of insolation***

Particle precipitation**

Atmospheric gravity waves

ULF wave activity

Spatio-temporal variations in the large-scale convection*

Spatio-temporal variations in neutral atmospheric species

Convection vortices driven by field-aligned currents

The DataBase & Analysis:

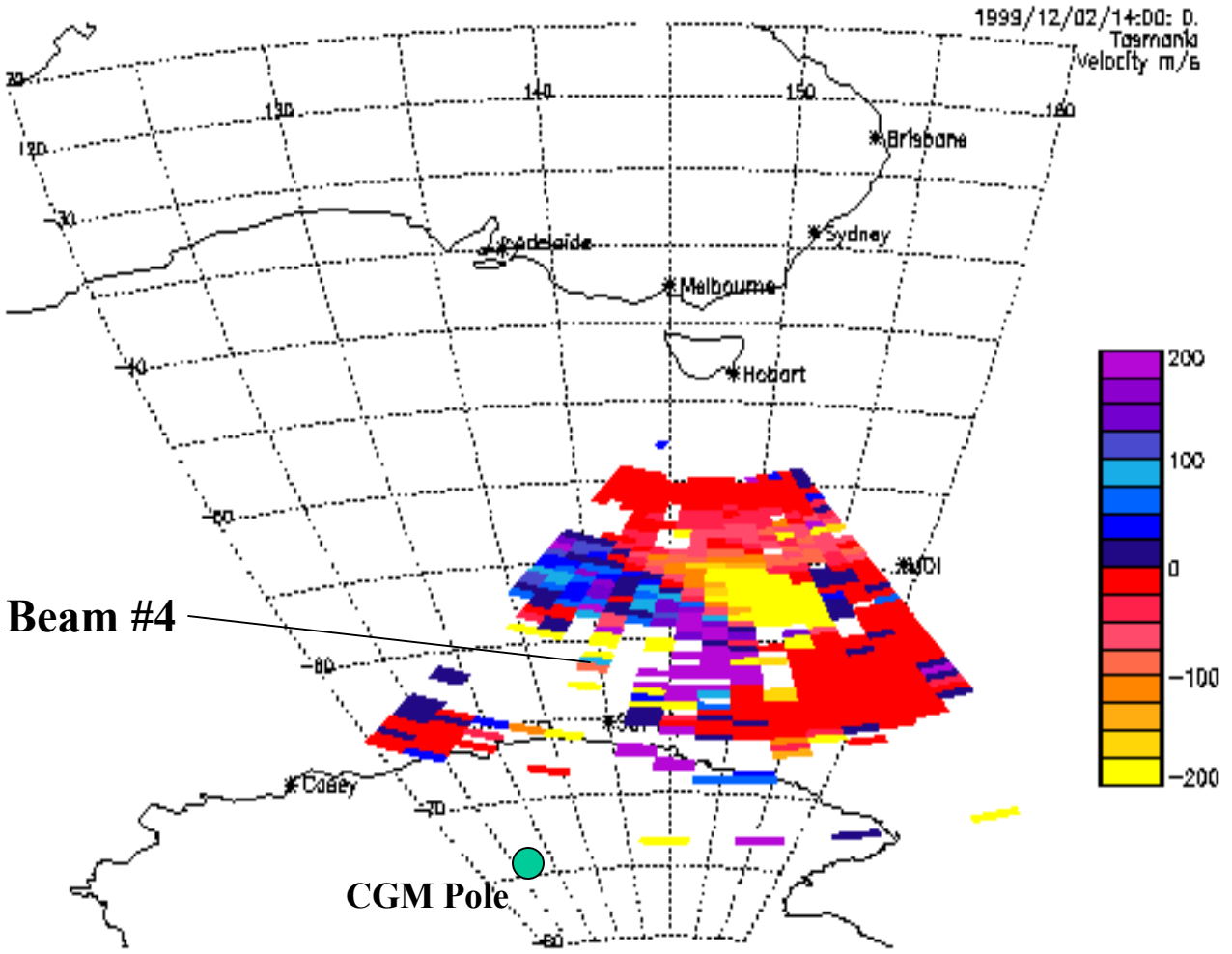
- **All the "normal_scan_nodata" and "normal_scan3" data recorded on TIGER beam #4 during the austral summer interval December, 1999 to February, 2000.**

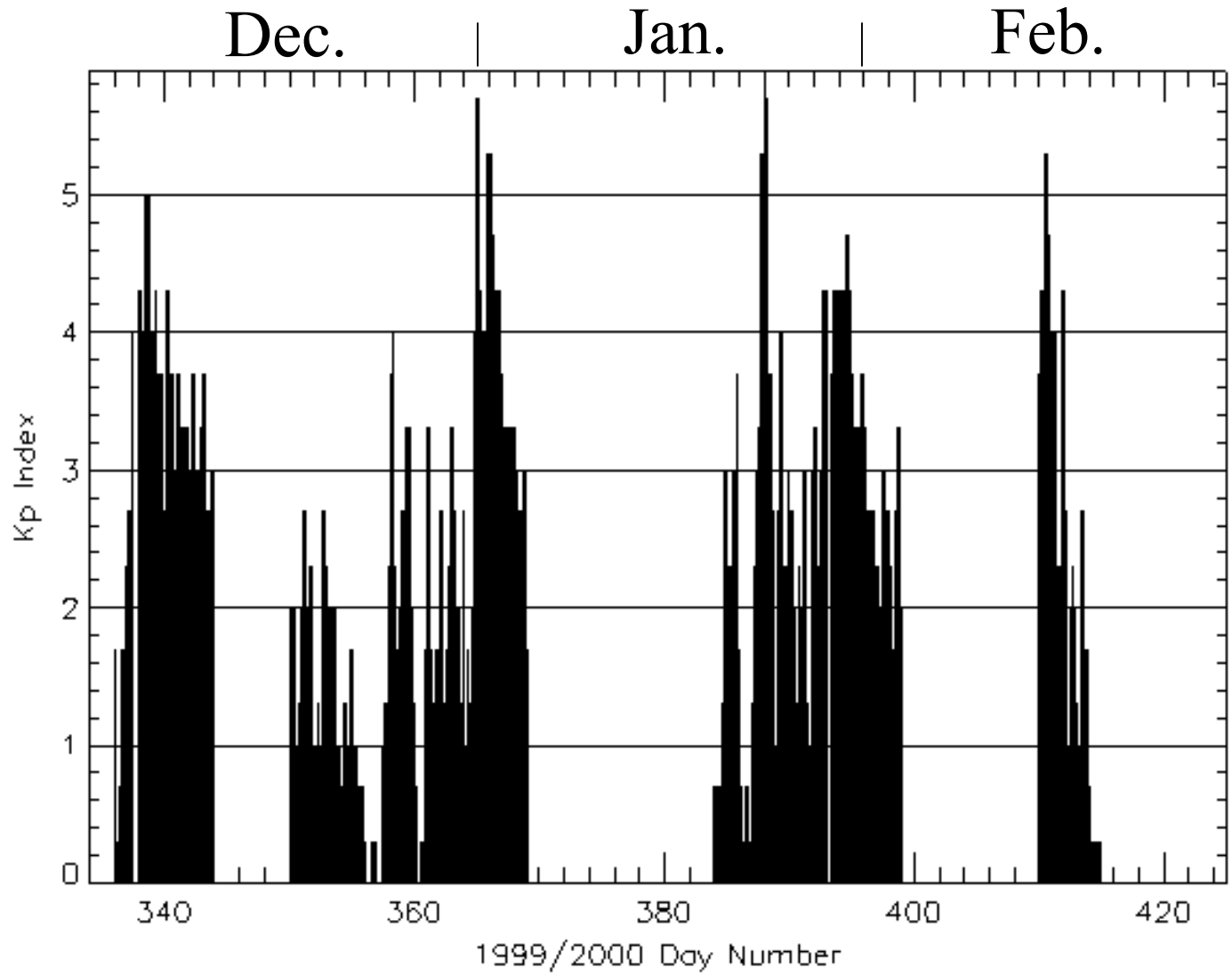
- **K_p indices from NGDC and ACE Level 2 interplanetary magnetic field (IMF) data.**

- **FITACF and XCF parameters were compiled for 31,468 separate beam #4 soundings evenly distributed in magnetic local time (MLT).**

- **The ACF/XCF parameters were sorted into 15-min bins in MLT, 75 default range bins, and the six K_p categories: all, 0–1, >1–2, >2–3, >3–4, ≥4, and the four basic IMF categories in the *By–Bz* plane.**

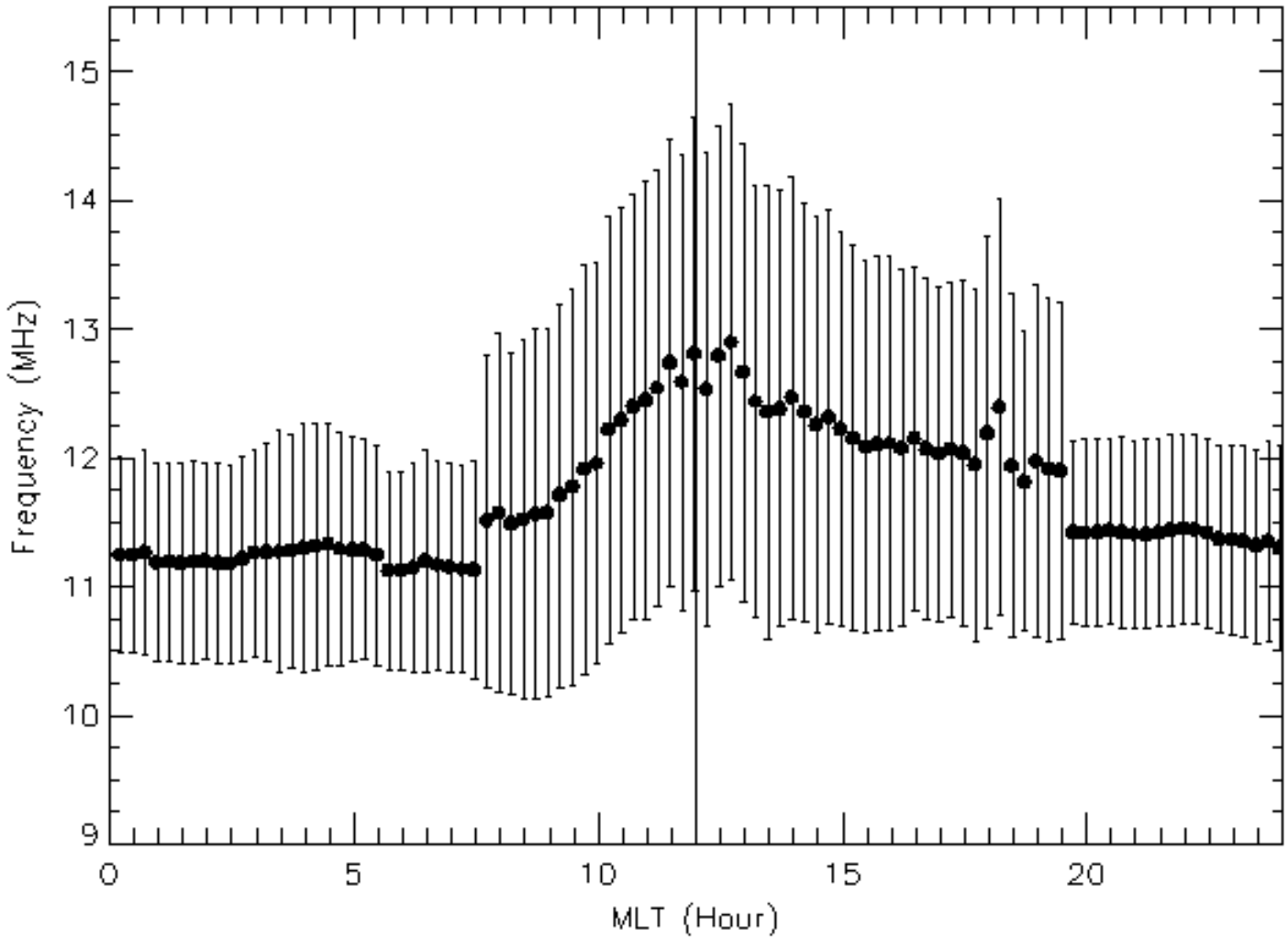
Why TIGER Beam #4?

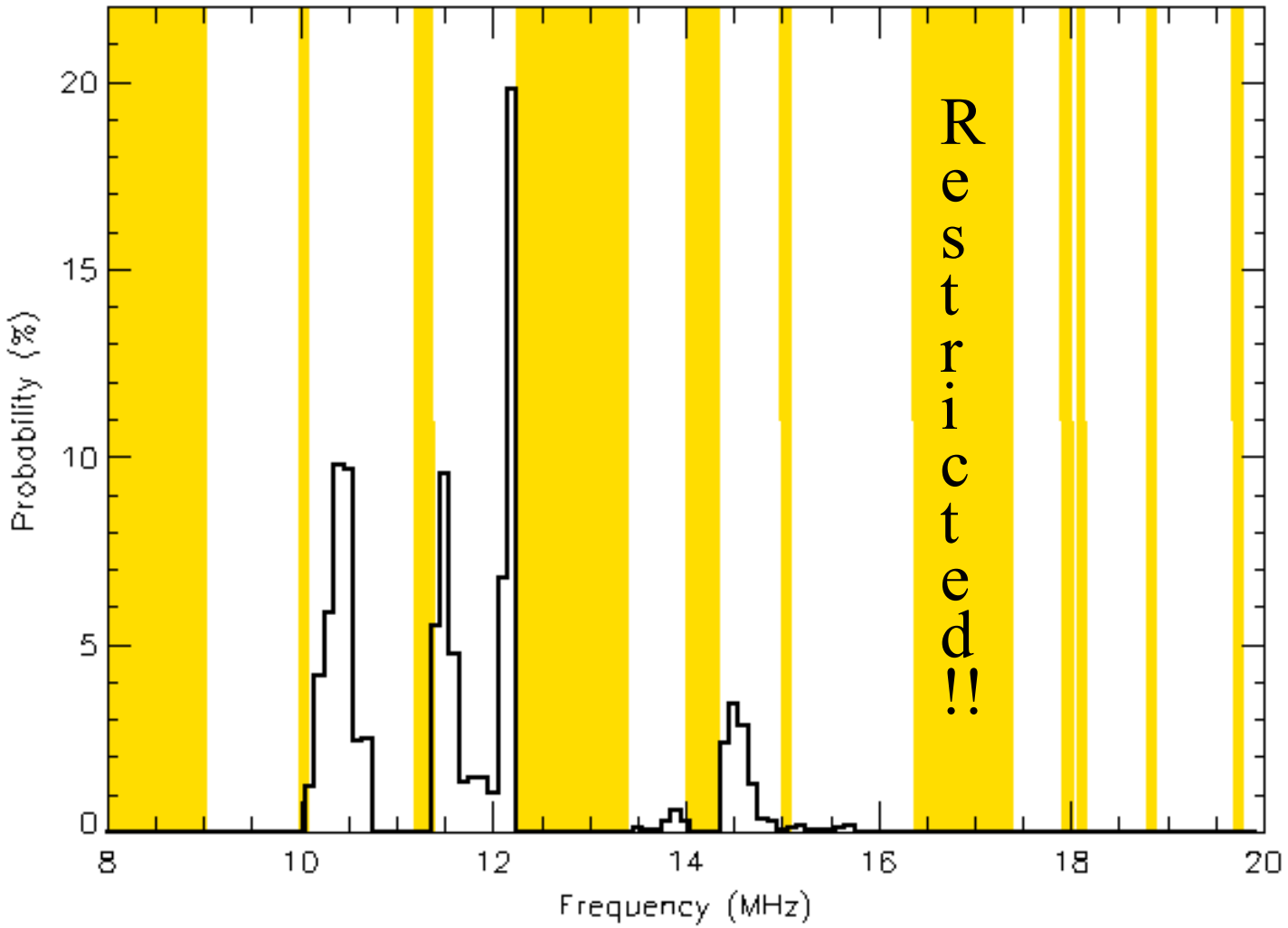




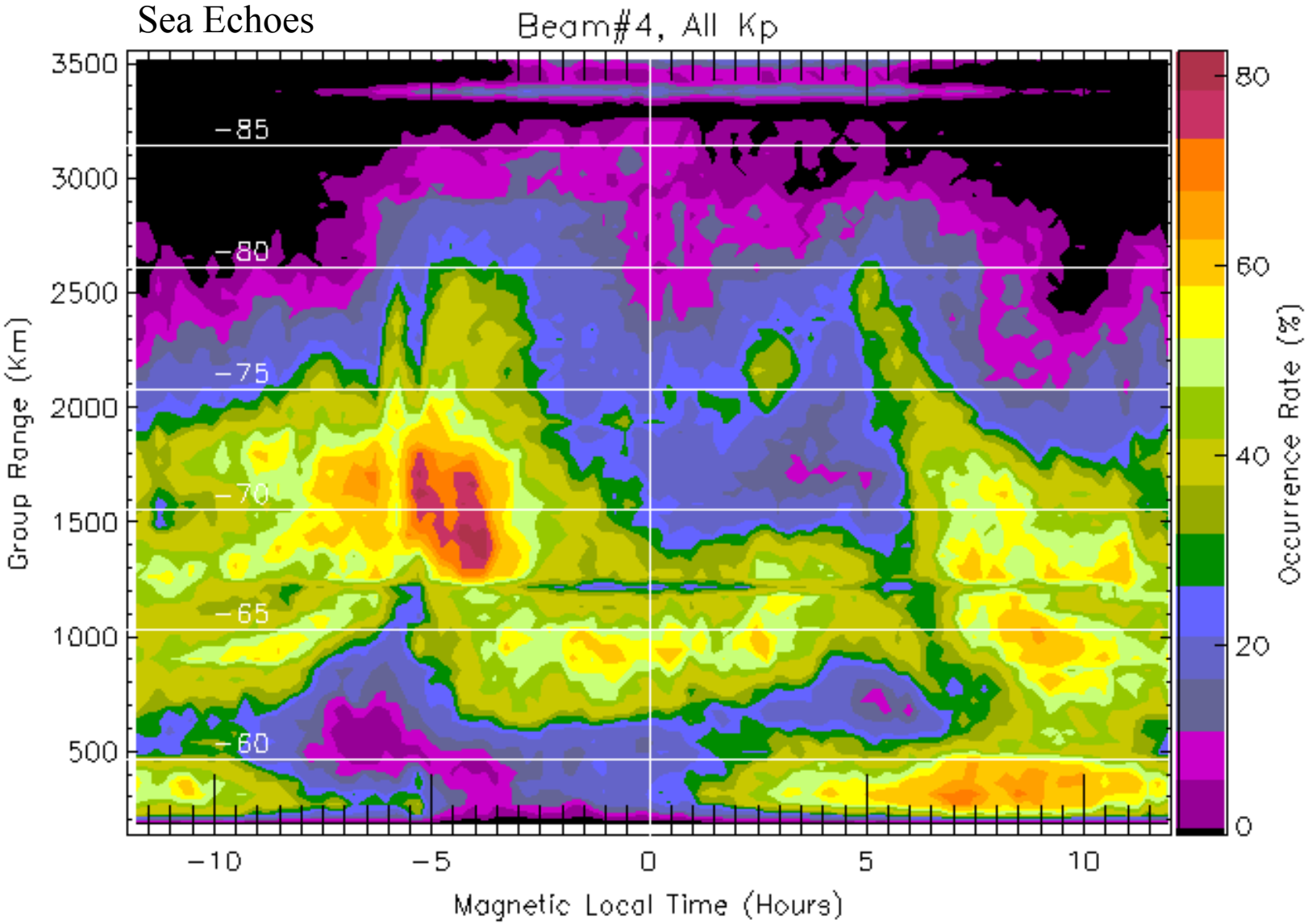
Day 001 = 1999 Jan. 01

Local Time ≈ MLT – 36 mins

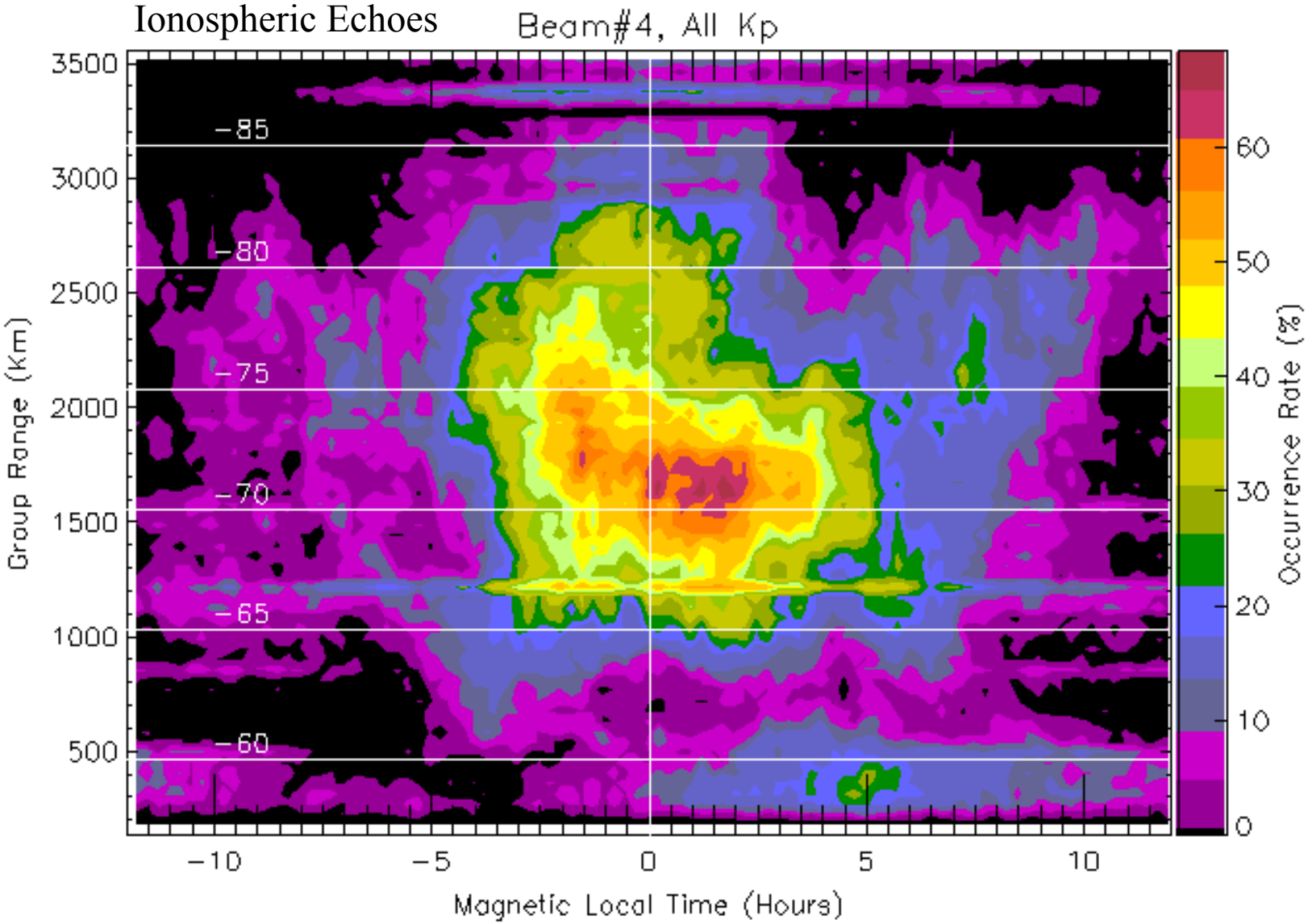


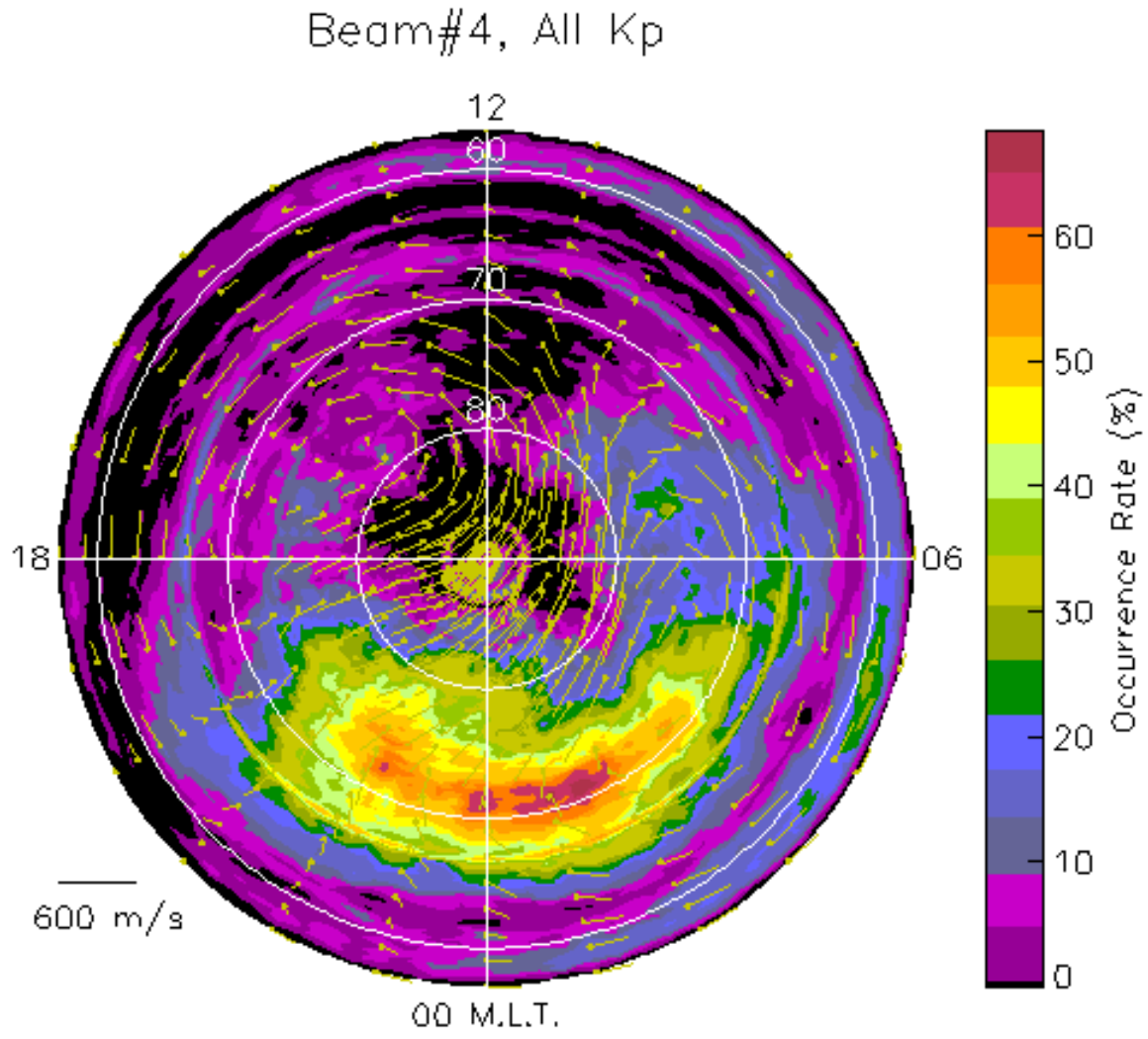

Probability (%)
0
5
10
15
20
8
10
12
14
16
18
20
Frequency (MHz)
Restricted!!

Sea Echoes

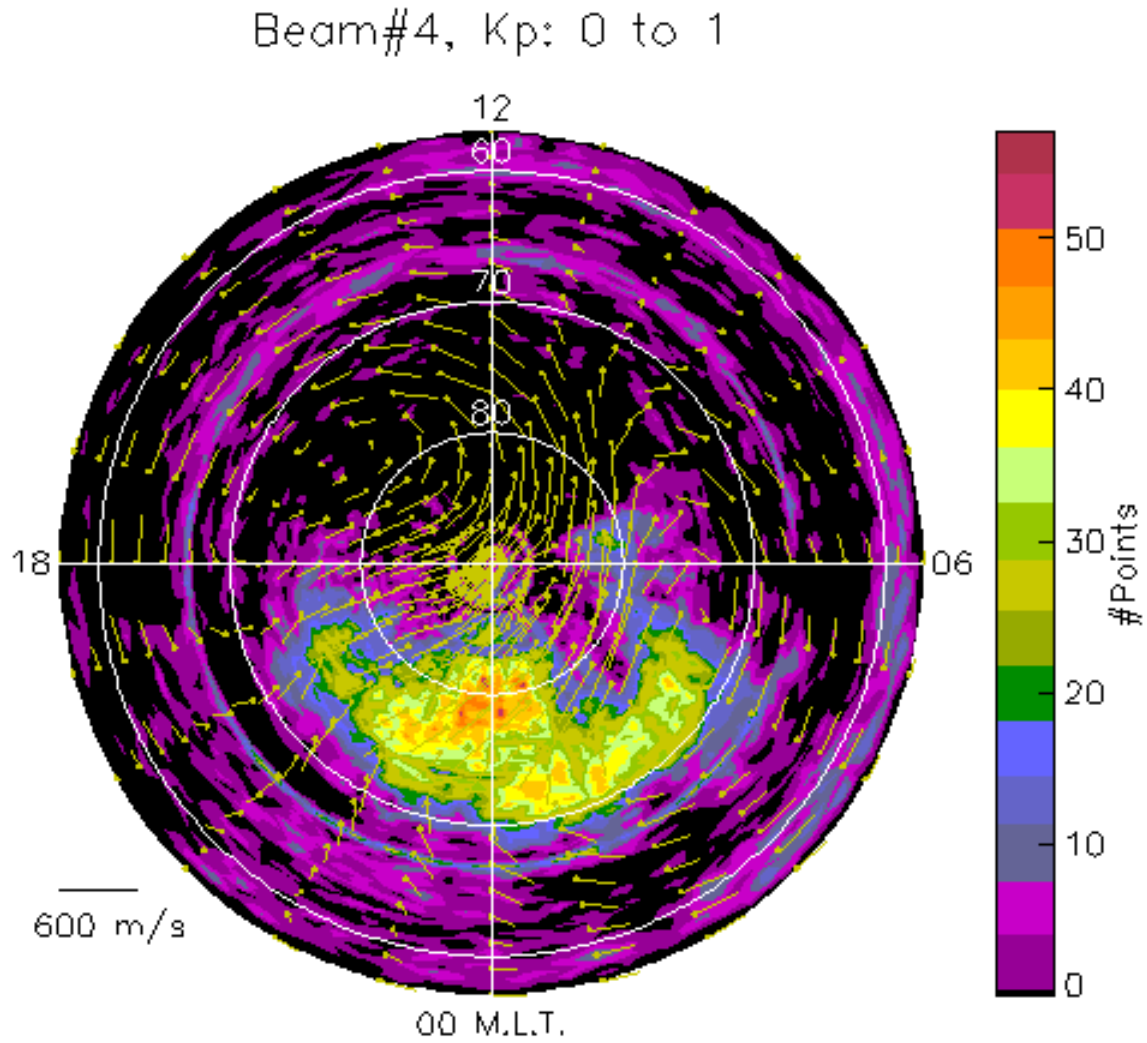

Beam#4, All Kp
3500
3000
2500
2000
1500
1000
500
-85
-80
-75
-70
-65
-60
Group Range (Km)
-10
-5
0
5
10
Magnetic Local Time (Hours)
80
60
40
20
0
Occurrence Rate (%)

Ionospheric Echoes





IZMEM Pattern, (B_x, B_y, B_z) = (0, 0, 0) nT



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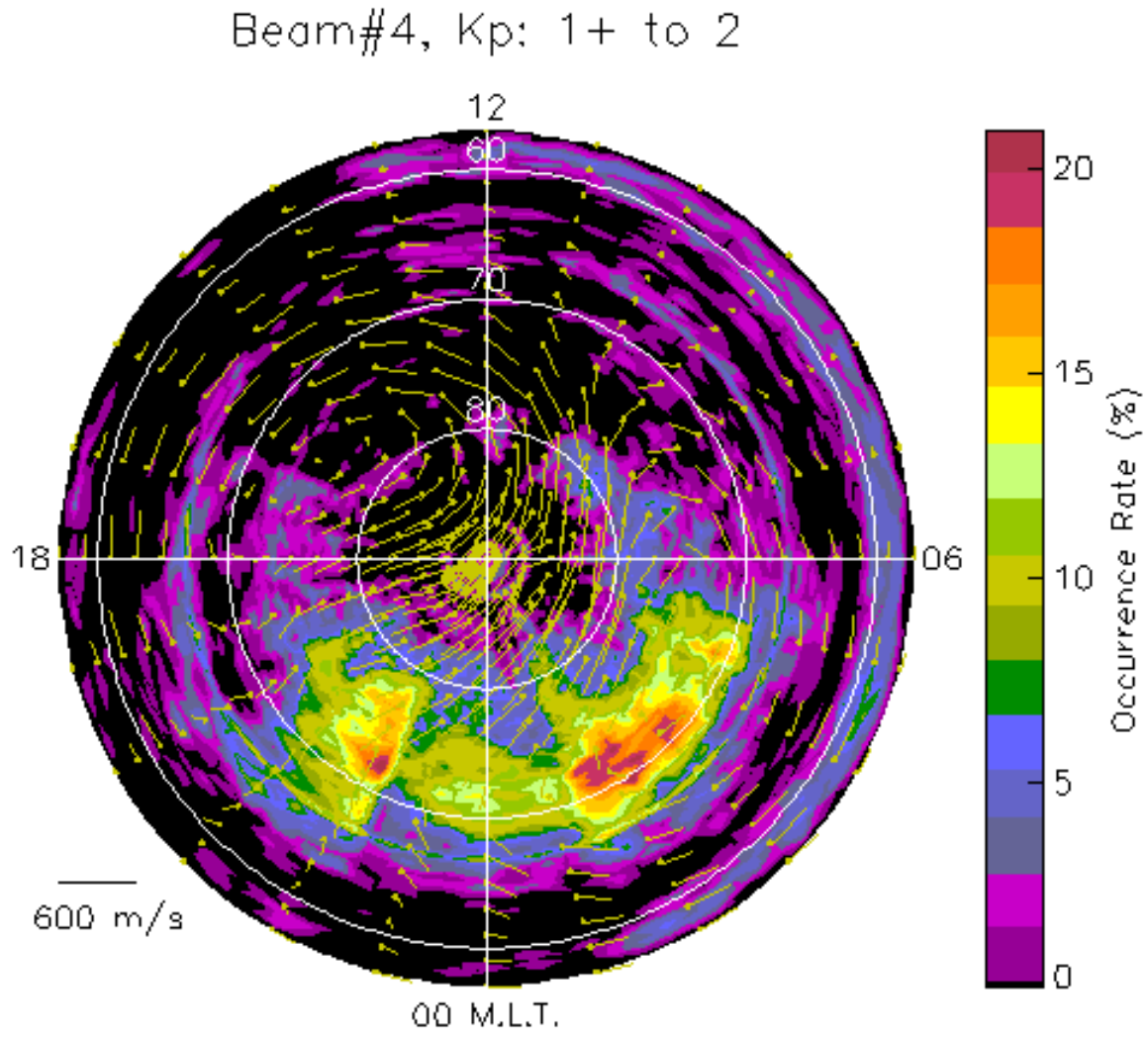

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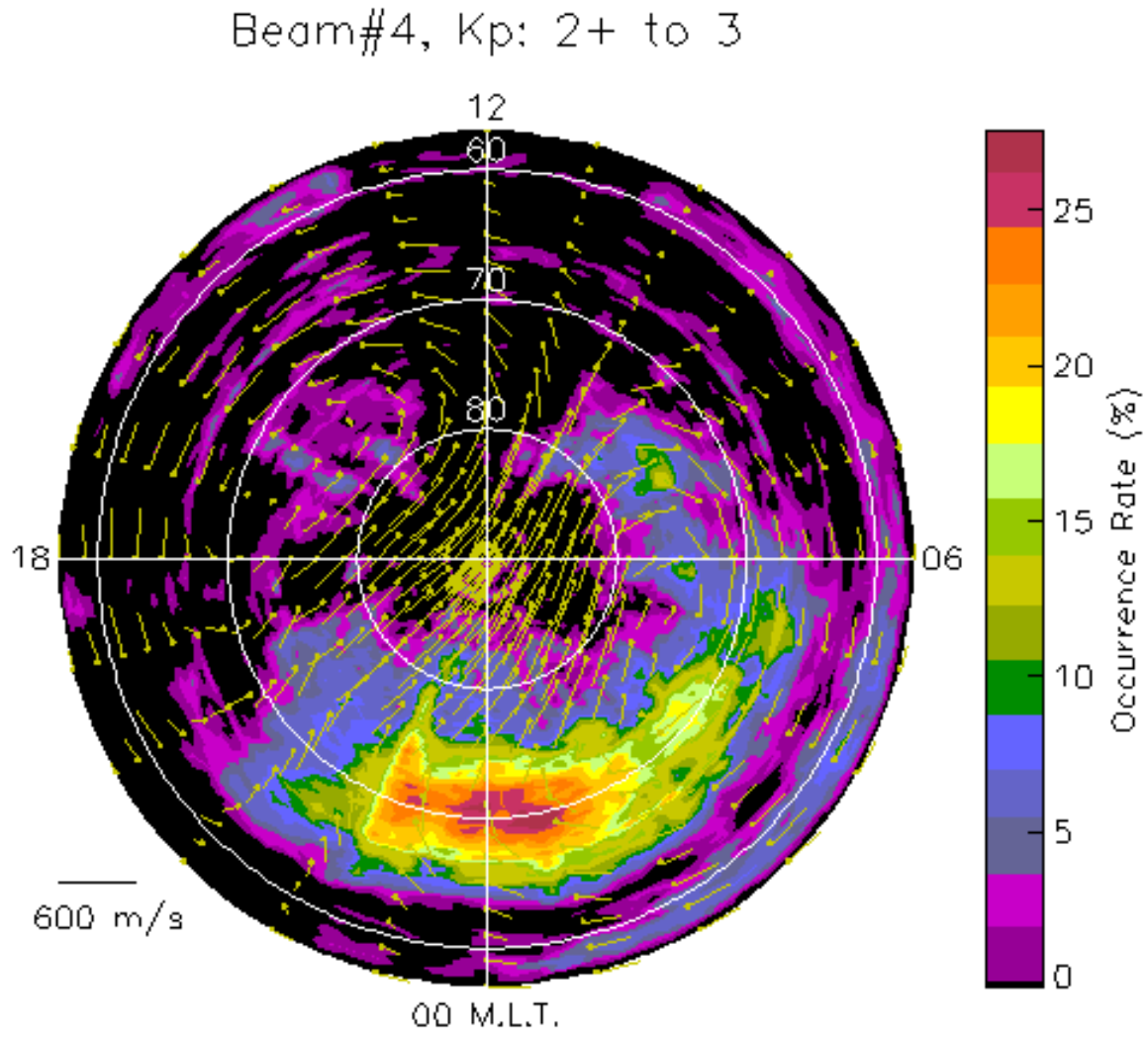

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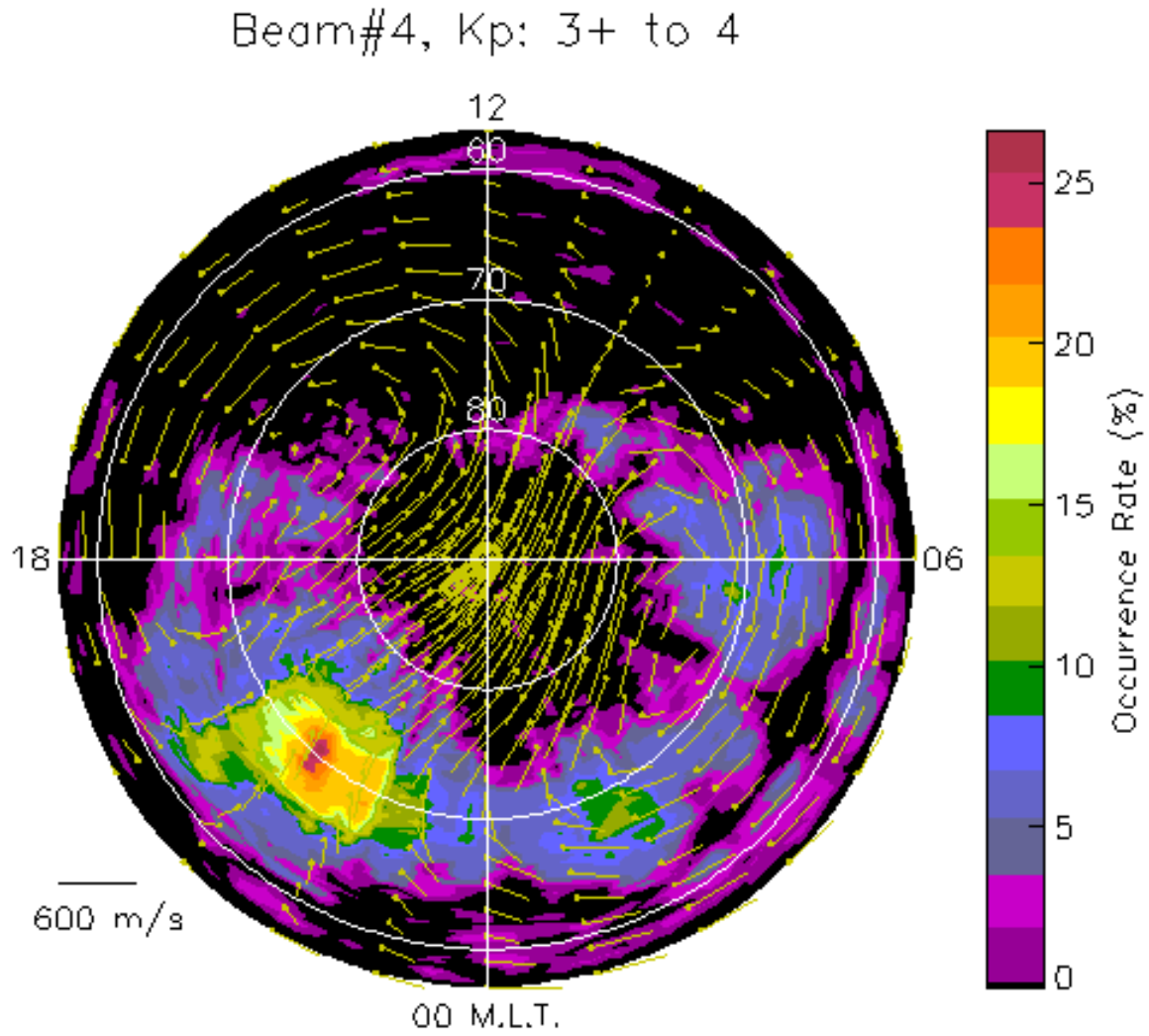

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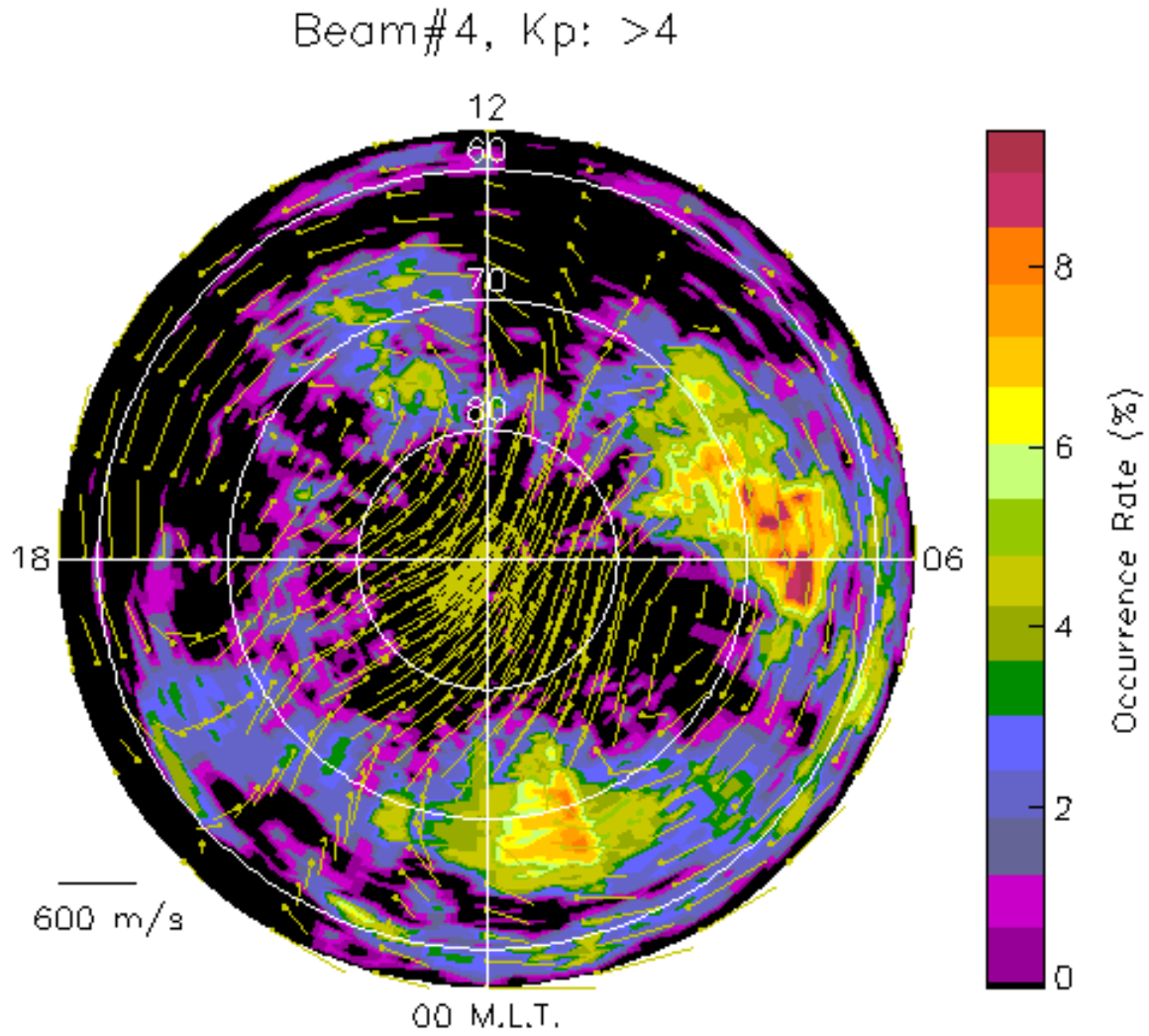

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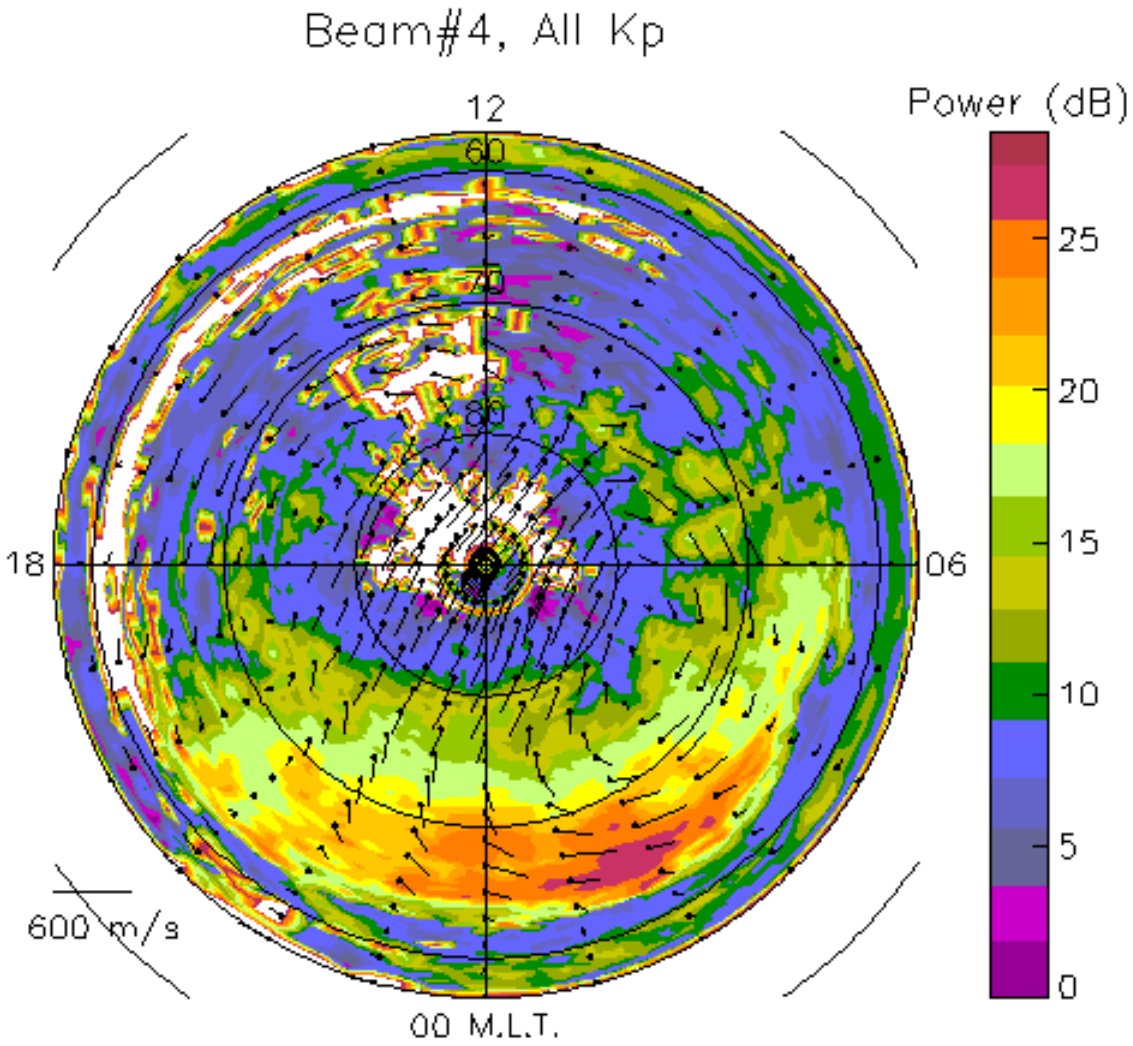
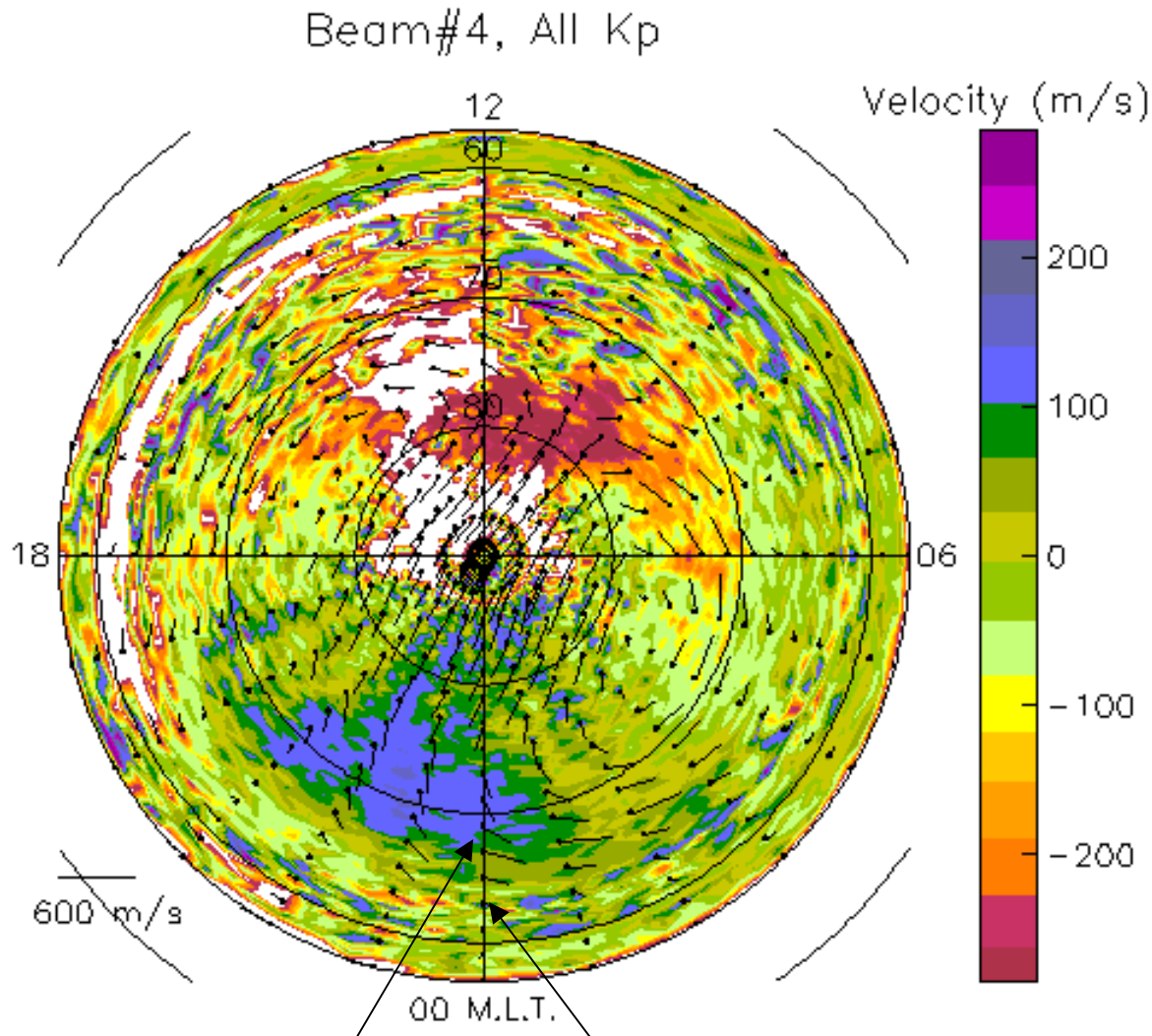
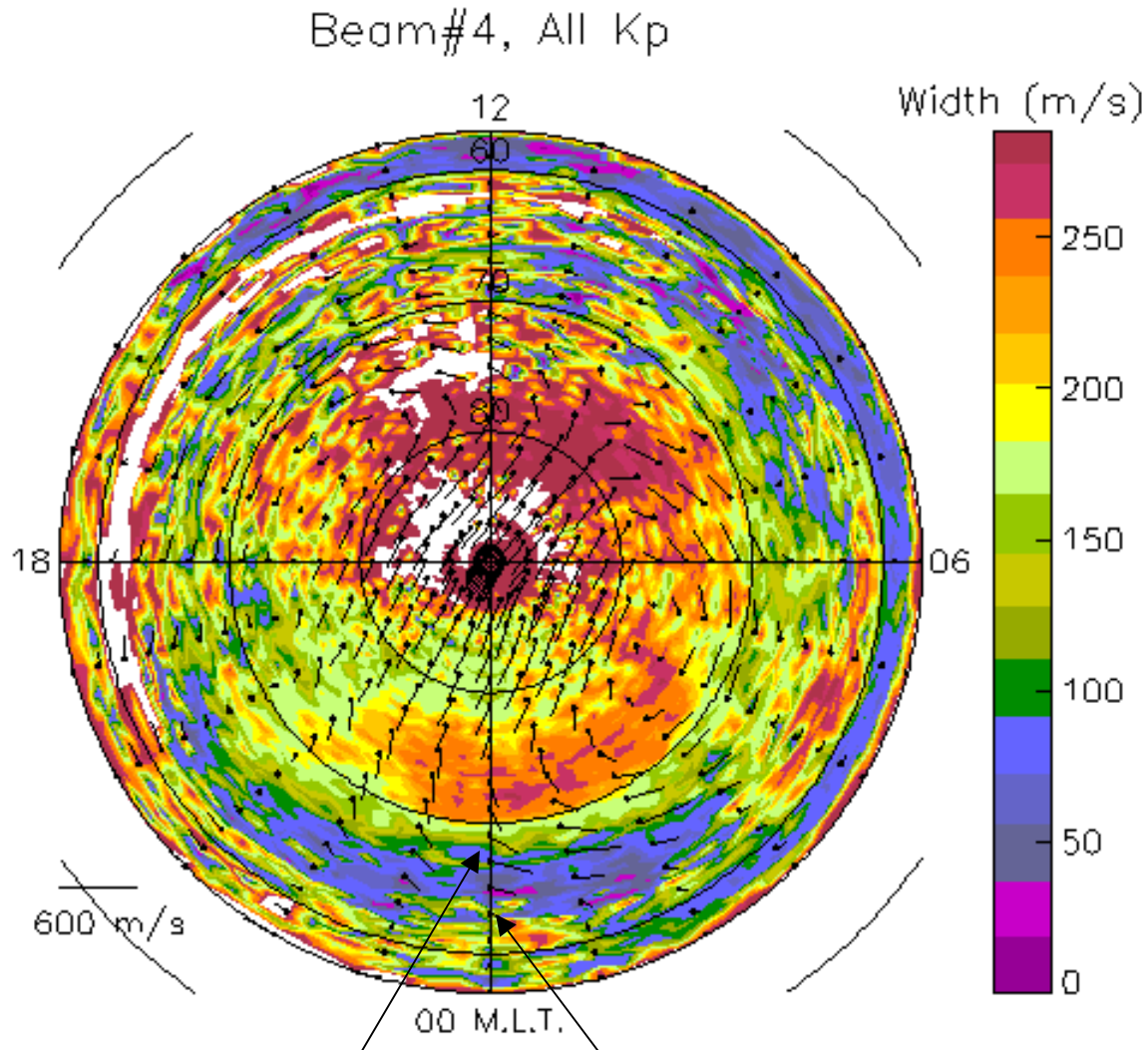


IZMEM Pattern, (B_x, B_y, B_z) = (0, 0, 0) nT



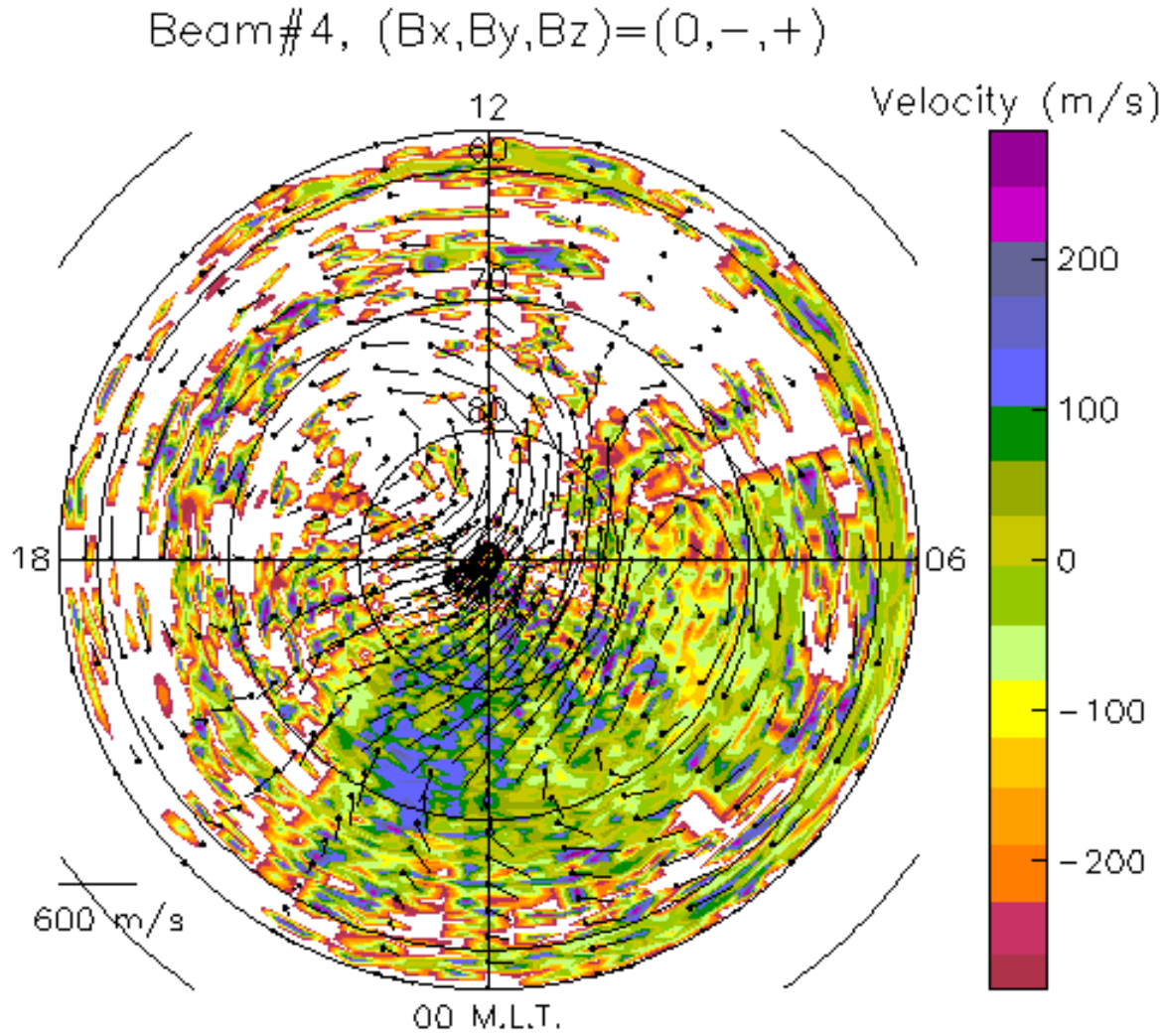
BPS/CPS?

Plasmapause?



BPS/CPS?

Plasmapause?



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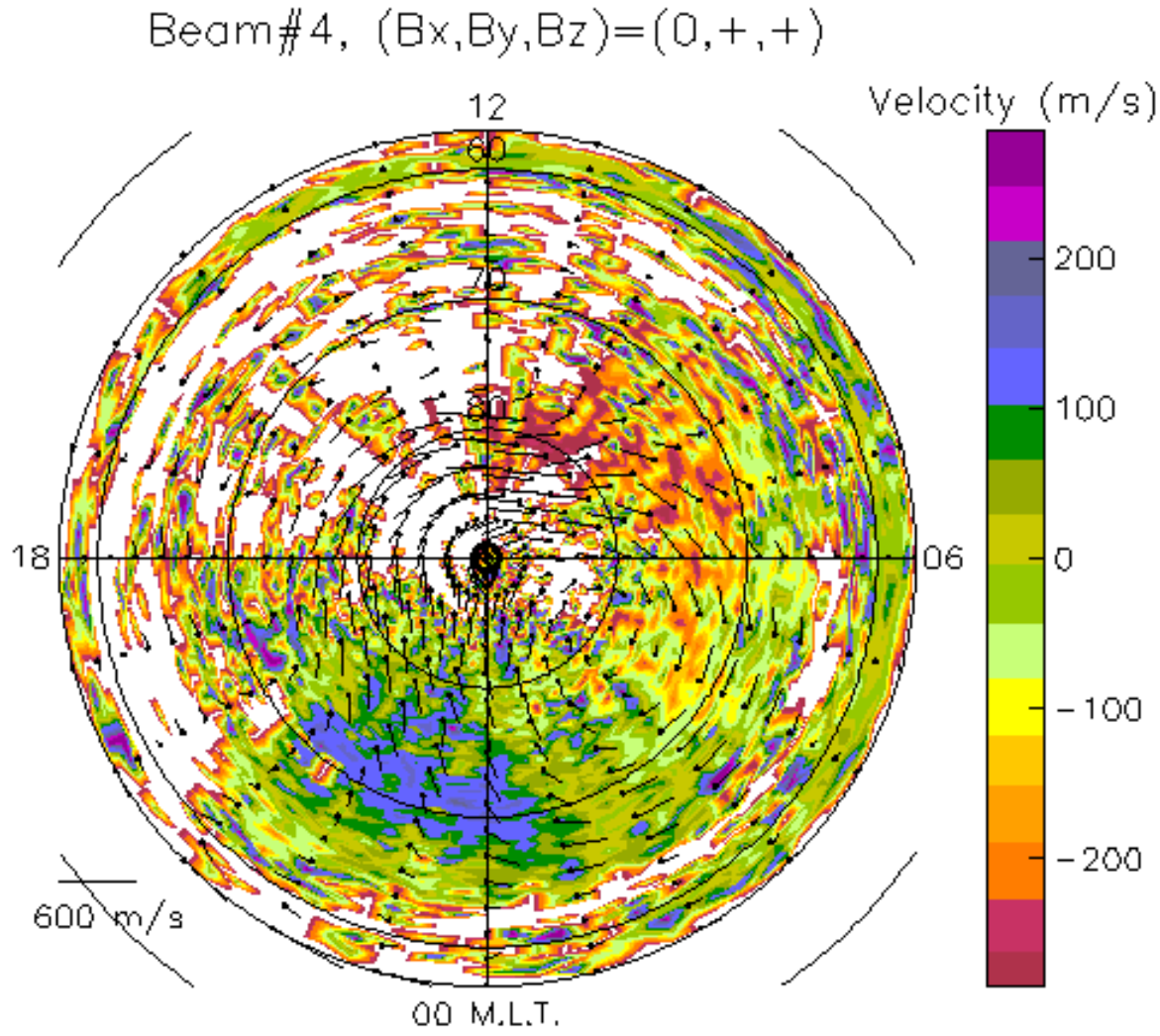
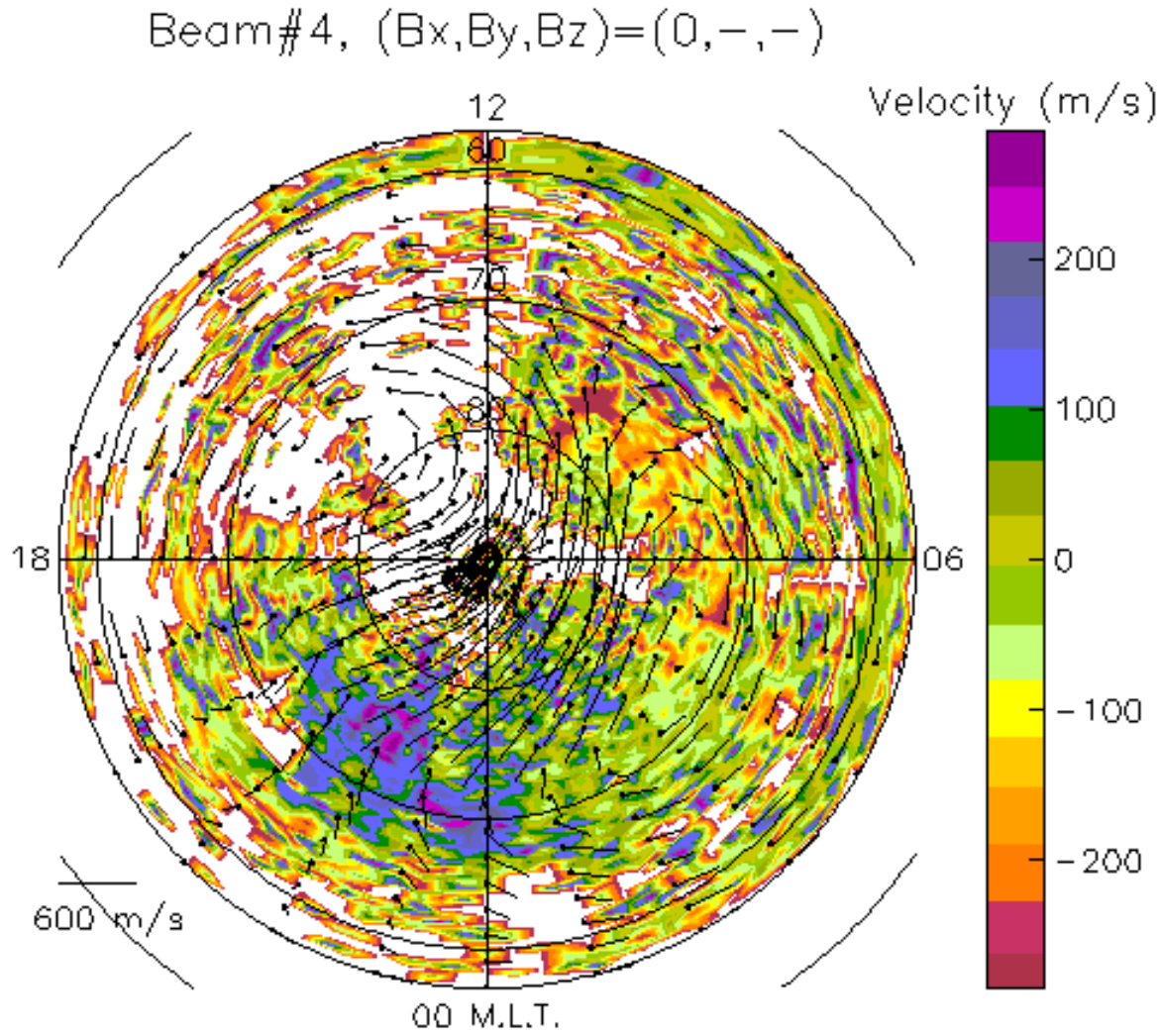


IZMEM Pattern, (B_x, B_y, B_z) = (0, 3, 3) nT



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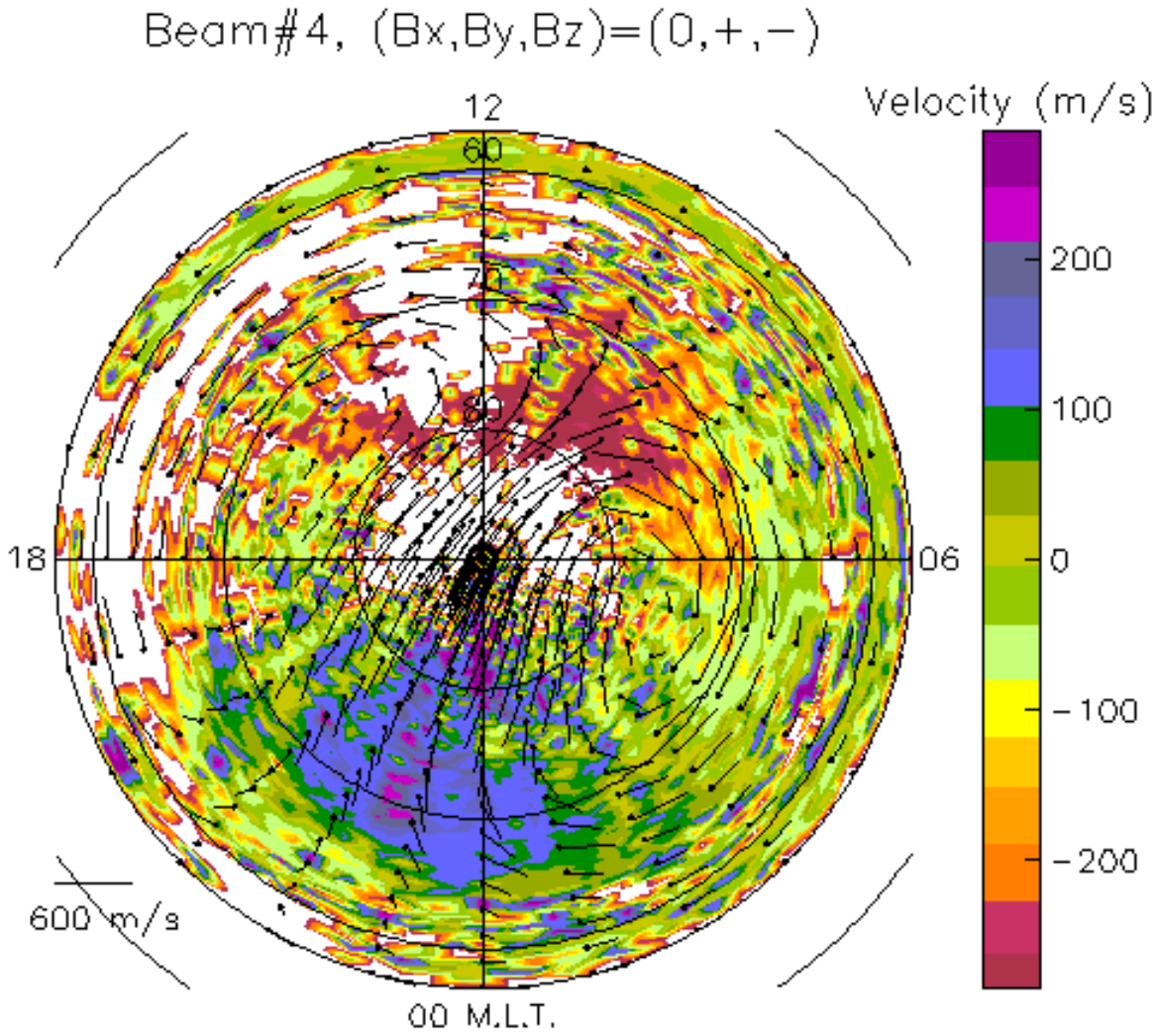


IZMEM Pattern, (B_x, B_y, B_z) = (0, 3, -3) nT

Summary

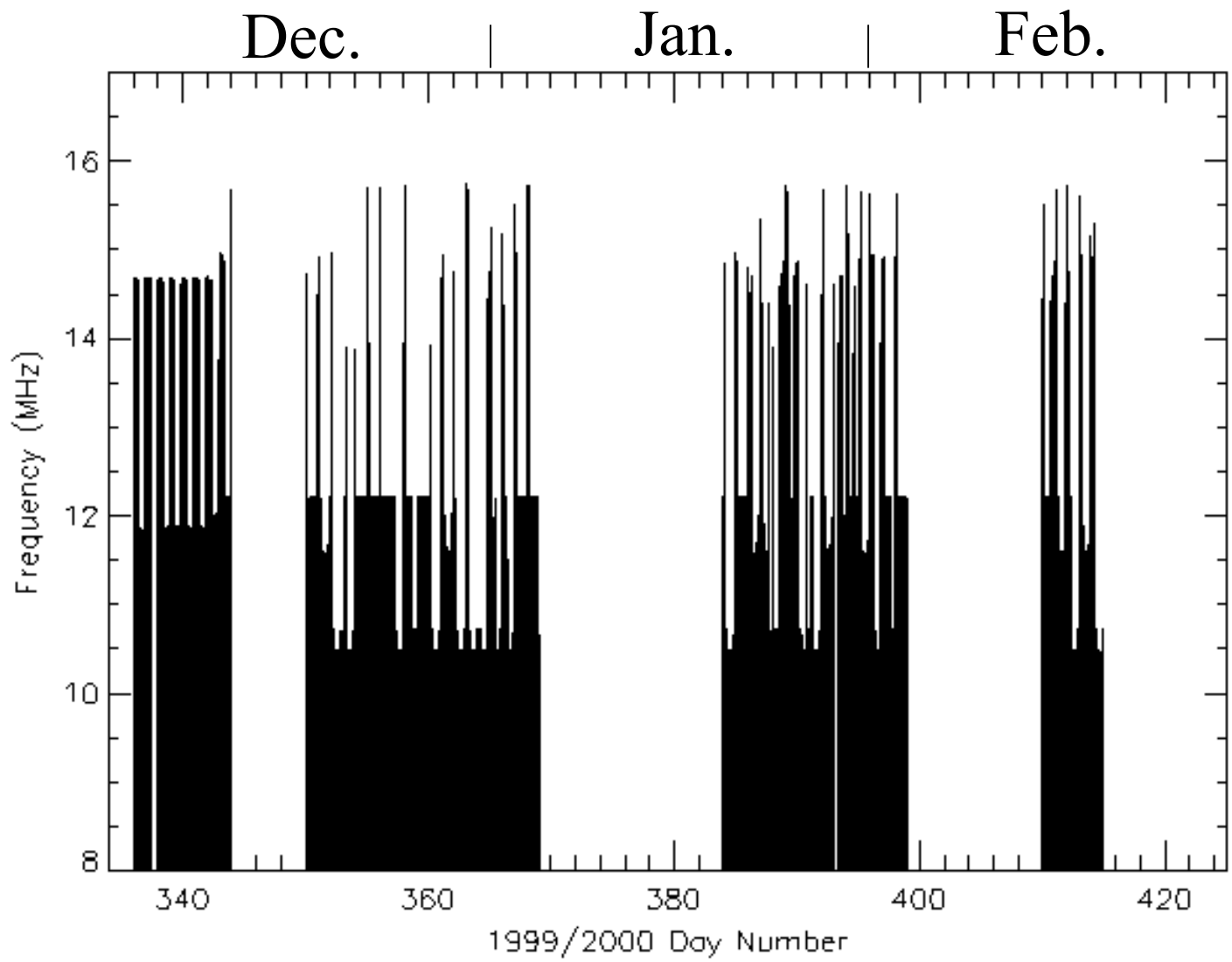
- **Most echoes detected by TIGER were caused by back-scatter from the Southern Ocean via the sky-wave mode (~65%).**
- **Most of the ionospheric echoes were caused by back-scatter from irregularities in the austral auroral oval, via the half- and 1.5-hop sky-wave modes (~32%).**
- **The ionospheric echoes mostly occurred on the night-side, with the peak occurrence (~70%) just beyond magnetic midnight. This peak moved equatorward with increasing K_p index, but the occurrence rate decreased dramatically with K_p, probably due to enhanced absorption.**

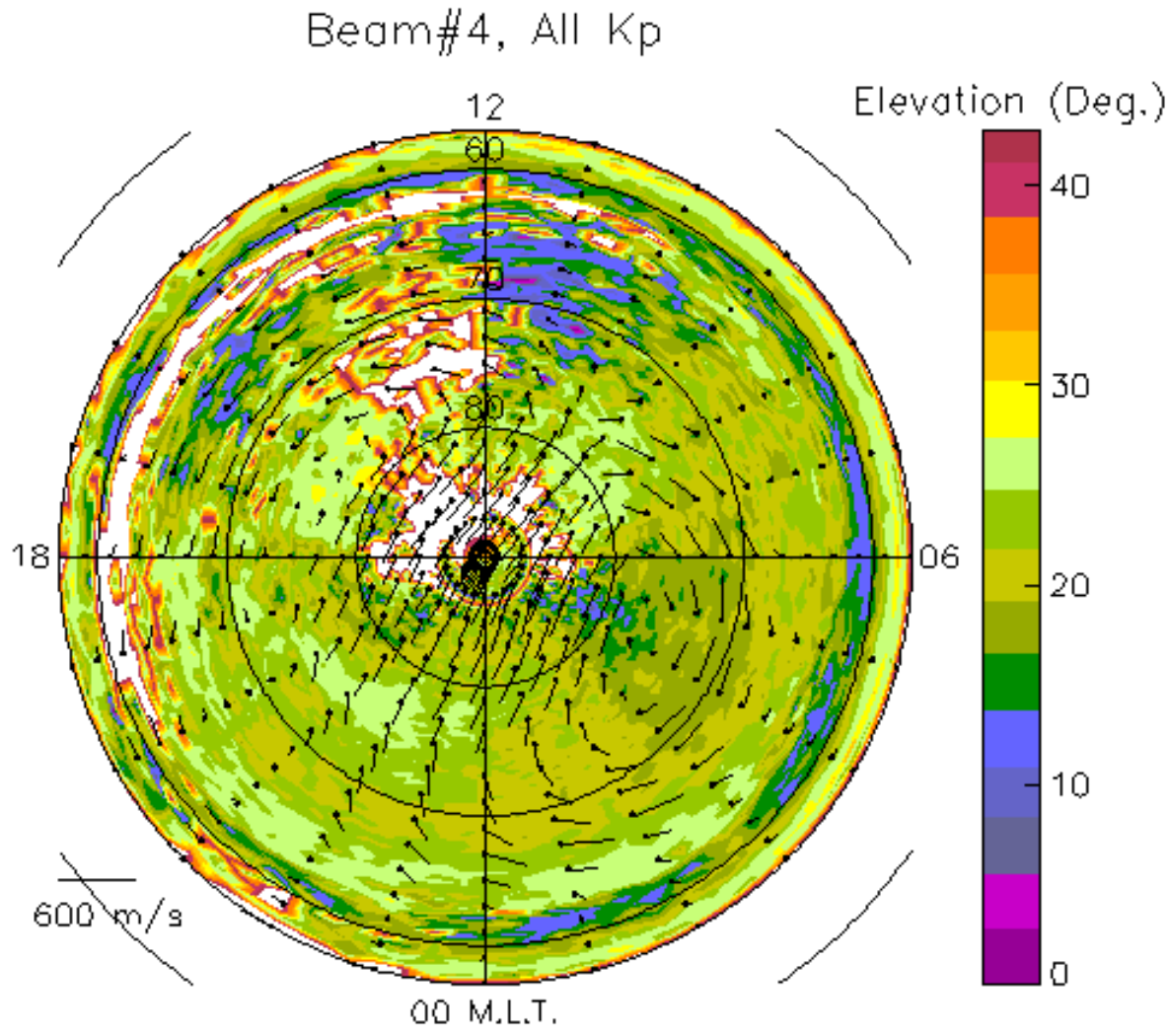
- **Maximum los velocities (~ –400 m s^{-1}) were associated with the pre-noon cusp/cleft region. The cross polar cap jet was well defined, with a sharp decrease in los velocity on the nightside at ~67°S.**

- **Maximum spectral widths (~500 m s^{-1}) were associated with the pre-noon cusp/cleft region. There was also a sharp decrease in spectral width on the nightside at ~67°S.**

- **The sharp decrease in los velocity and spectral width on the nightside may be related to signatures of the boundary plasma sheet, plasmapause, and main ionospheric trough measured by other instruments.**

- ***E*-region scatter peaked at about 5 h MLT ???**


Dec.
Jan.
Feb.
16
14
12
10
8
Frequency (MHz)
340
360
380
400
420
1999/2000 Day Number



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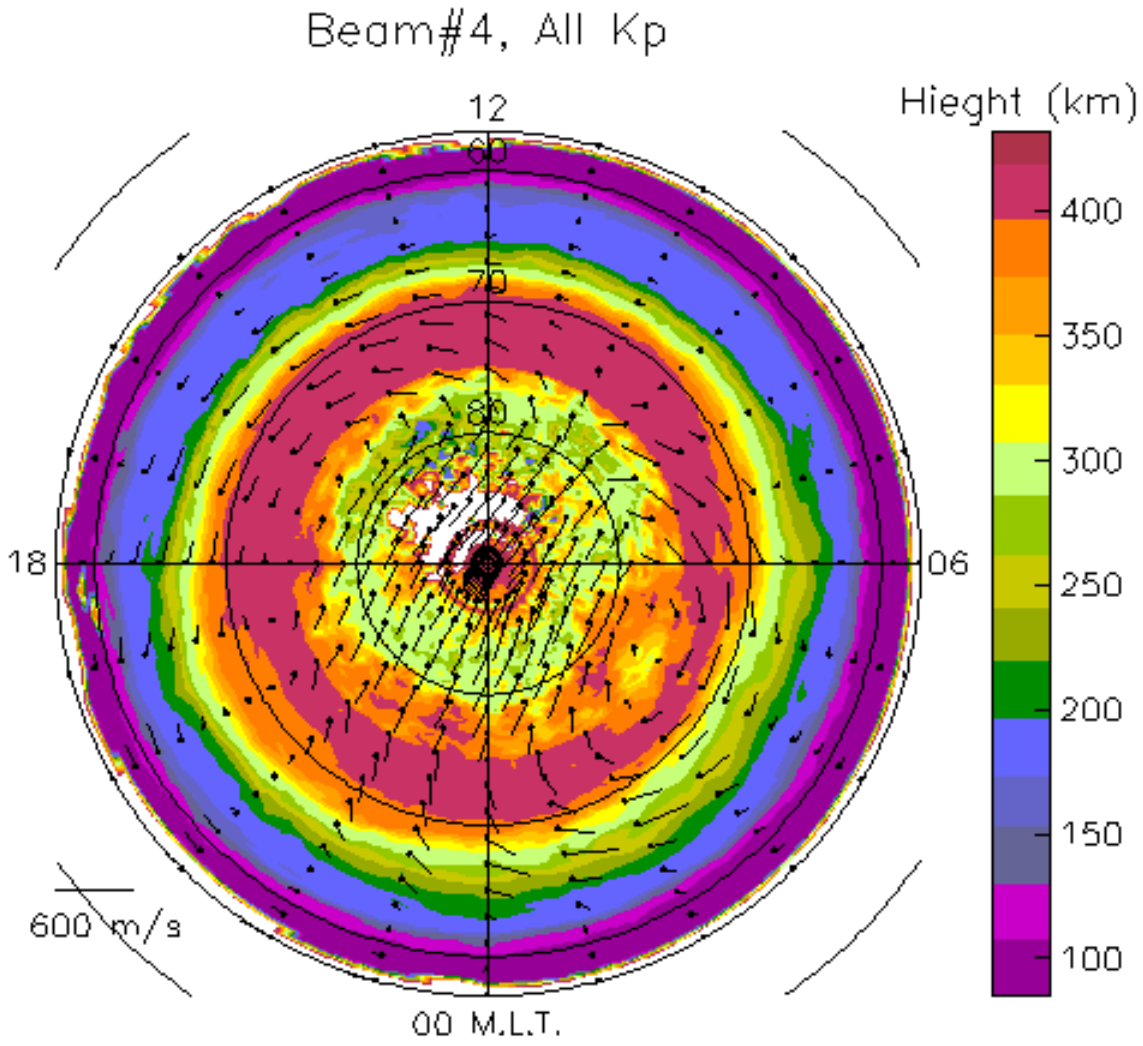

Sea Echoes–Equivalent Heights

Summary

- **Most echoes detected by TIGER were caused by back-scatter from the Southern Ocean via the sky-wave mode (~65%), but also via the surface-wave mode (<1.5%)?**

- **Most of the ionospheric echoes were caused by back-scatter from irregularities in the austral auroral oval, via the half- and 1.5-hop sky-wave modes (~32%), but there was also evidence for "direct los echoes" (<2.5%)?**

- **The ionospheric echoes mostly occurred on the night-side, with a peak occurrence (~70%) just beyond magnet-ic midnight. The peak occurrence moves equatorward and to later MLT with increasing K_p index. The best coverage in MLT and range was achieved for K_p in the range ~2+ to 3.**

• Maximum los velocities (~ –400 m s^{-1}) were associated with the pre-noon cusp/cleft region. The cross polar cap jet was well defined, with a sharp decrease in los velocity on the nightside at ~67°S. Plasmapause signature?

•Maximum spectral widths (~500 m s^{-1}) were associated with the pre-noon cusp/cleft region region. Again, there was a sharp decrease in spectral width on the nightside at ~67°S. Plasmapause signature?

• *E*-region scatter peaked at about 5 h MLT ???

• The average amplitudes of ionospheric echoes decreased with range^{-2}.

• The elevation angles of sea echoes were mostly in the range 20 to 26°.