Kiljava, Finland

2003

FINNISH METEOROLOGICAL INSTITUTE
GEOPHYSICAL RESEARCH

The possible role of ion-neutral slip velocity in the formation of decametre-scale irregularities in the high-latitude ionosphere

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Basic Mechanics of the E×B Instability:

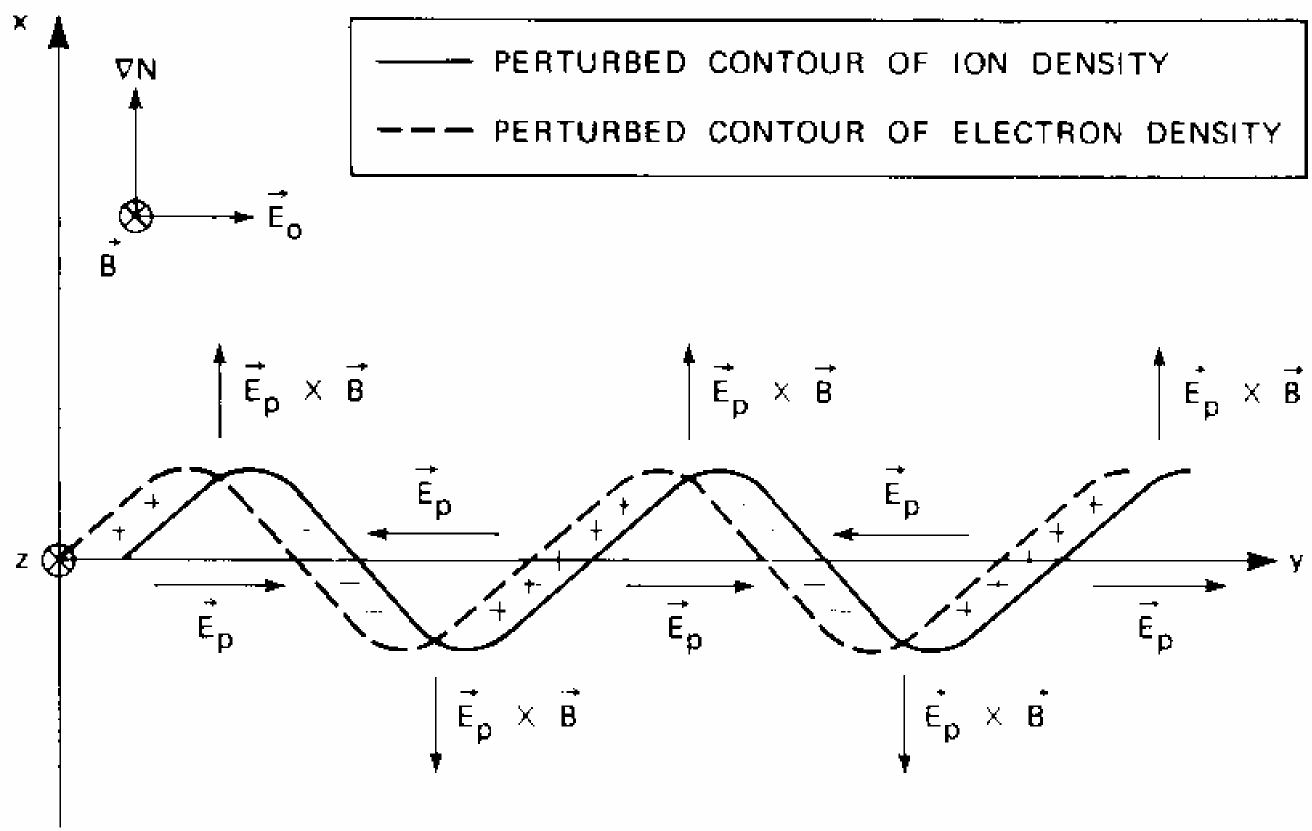


Fig. 21. Simplified schematic diagram showing the basic mechanics of the $\vec{E} \times \vec{B}$ instability. A Pedersen ion drift (to the right) leads to charge separation and the development of polarization electric fields, $\vec{E}_p$. The sense of $\vec{E}_p$ is to drive $\vec{E}_p \times \vec{B}$ motion that further enhances the original plasma perturbation.

Roland T. Tsunoda, "High-Latitude F Region Irregularities: A Review and Synthesis," Rev. Geophys., 26, 719-760, 1988

Basic Mechanics of the E×B Instability:

The simplest, one-dimensional, linear growth rate, γ_0, for the ***E***×***B*** *instability with* ***k***·***B*** *= 0, kL >>1 is*

$$\gamma_0 = V_0 / L, \qquad \omega << \nu_{in}$$

where

$V_0 = V - U$, *the "slip" velocity, the plasma drift, V, relative to the neutral wind U,*

$L = [(1/n_e)(dn_e/dx)]^{-1}$, *the gradient scale length,*

$\omega = \omega_r + i\,\gamma_0$, *the wave frequency* ($e^{-i\omega} = e^{-i\omega_r}e^{\gamma}$),

$k = 1/\lambda$, *the irregularity wave number,*

$\nu_{in} =$ *the ion-neutral collision frequency,*

$n_e =$ *the plasma density.*

Chatanika Incoherent Scatter Radar (147.4°W, 65.1°N, 58.4°Λ)

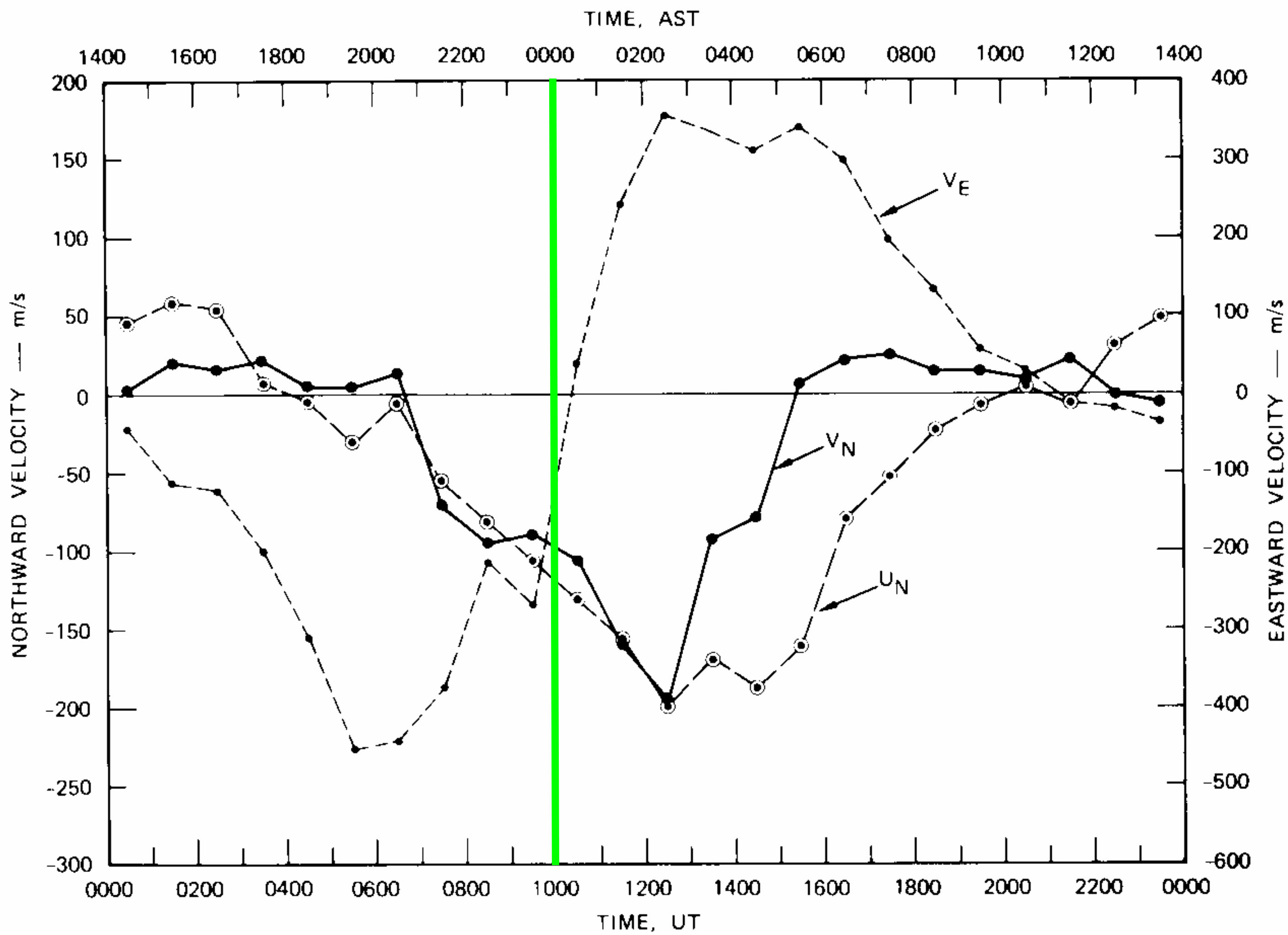
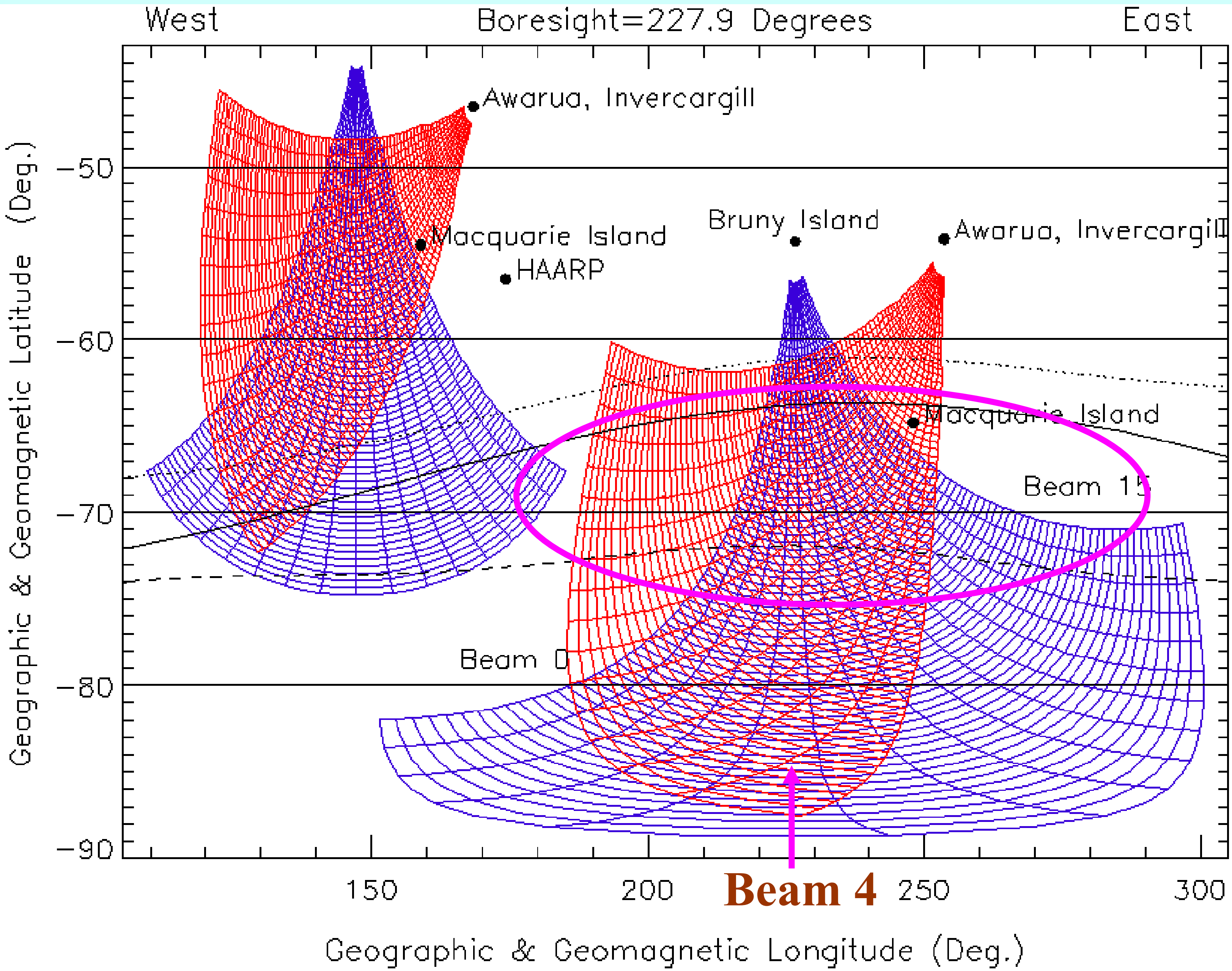


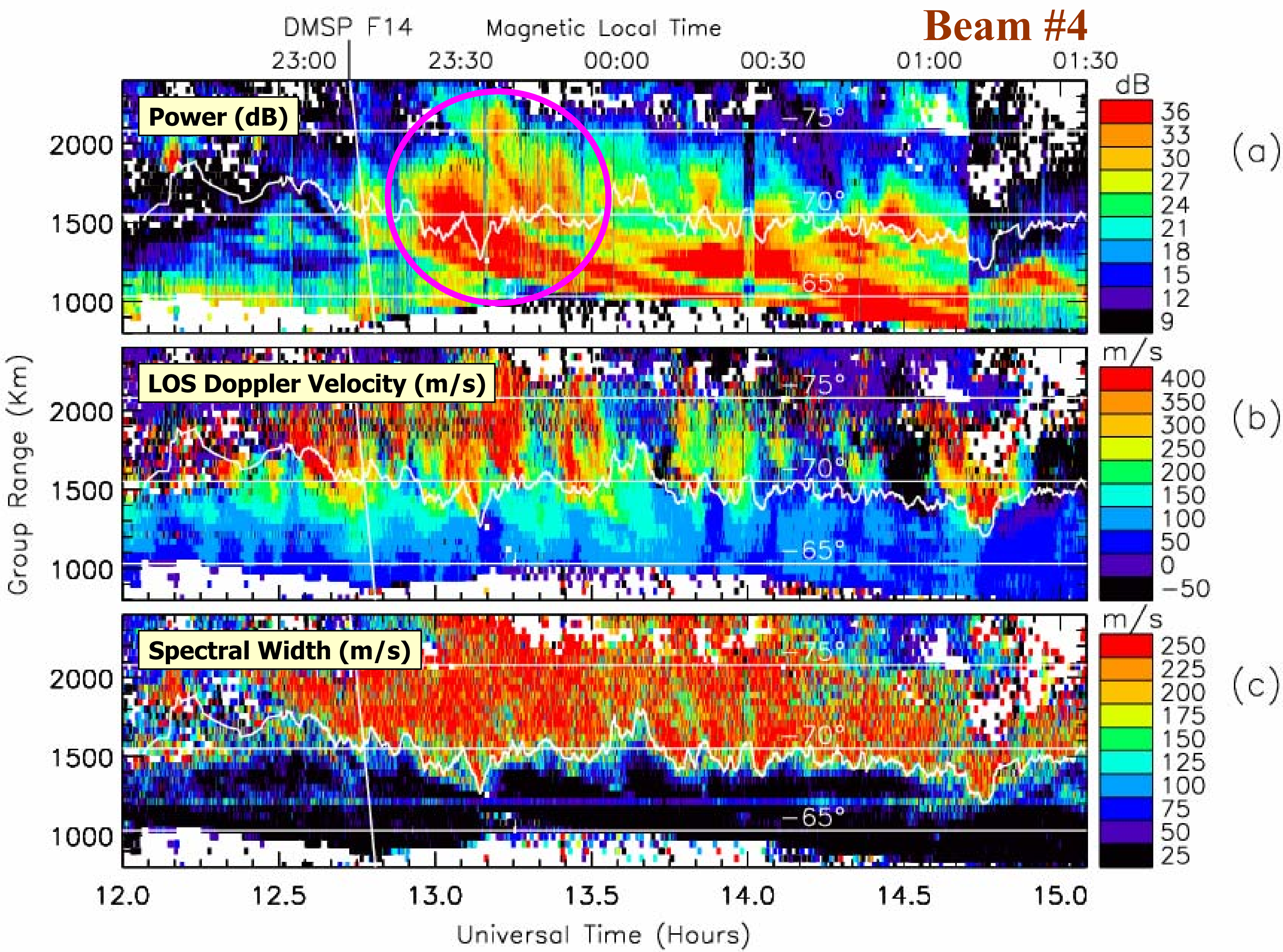
Fig. 29. Diurnal variation in the meridional neutral wind determined from Chatanika incoherent-scatter measurements and associated convection velocity components.

Roland T. Tsunoda, "High-Latitude F Region Irregularities: A Review and Synthesis," Rev. Geophys., 26, 719-760, 1988

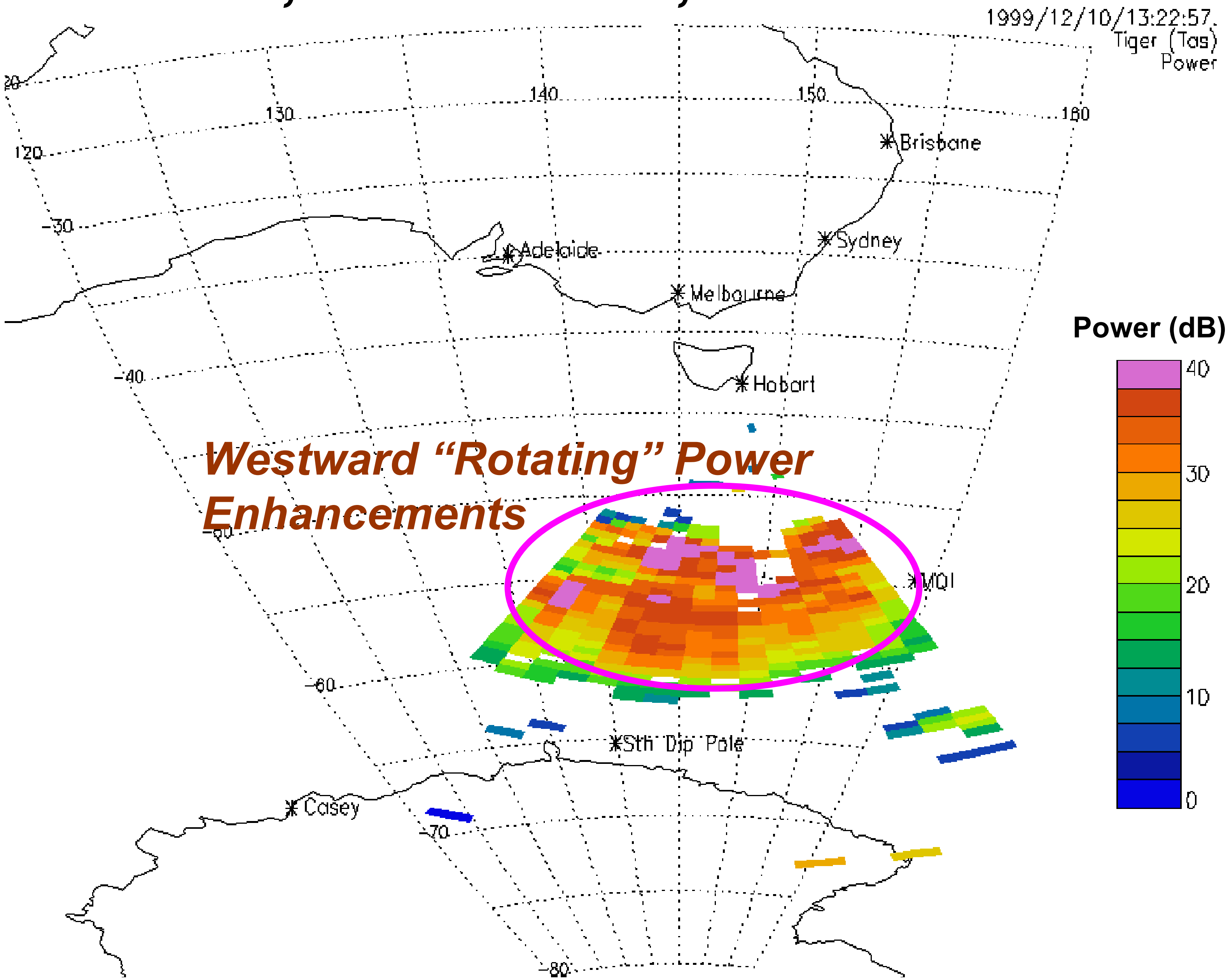
TIGER I & II Field of Views:



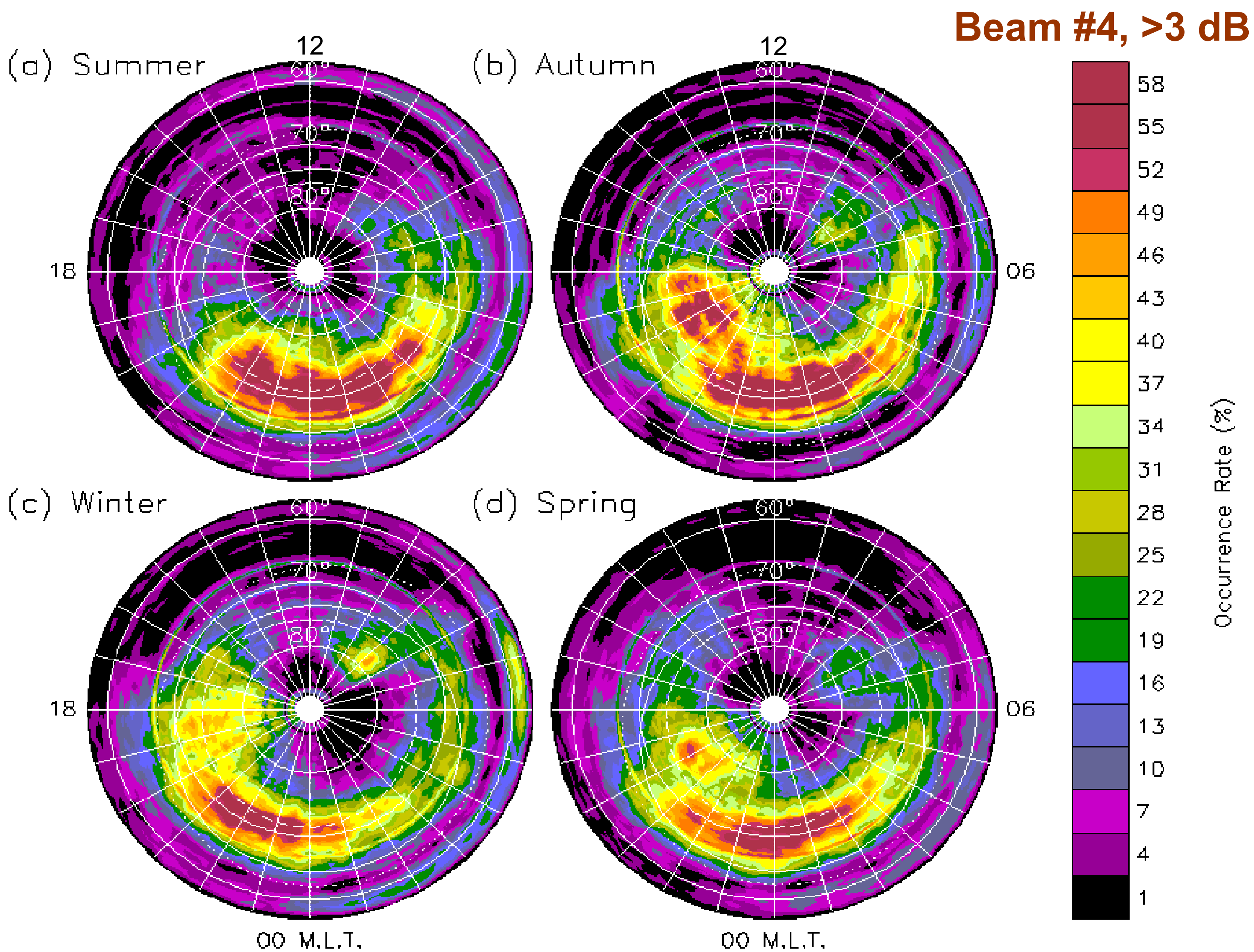
TIGER Tasmania Range-Time Plot, 10 December, 1999



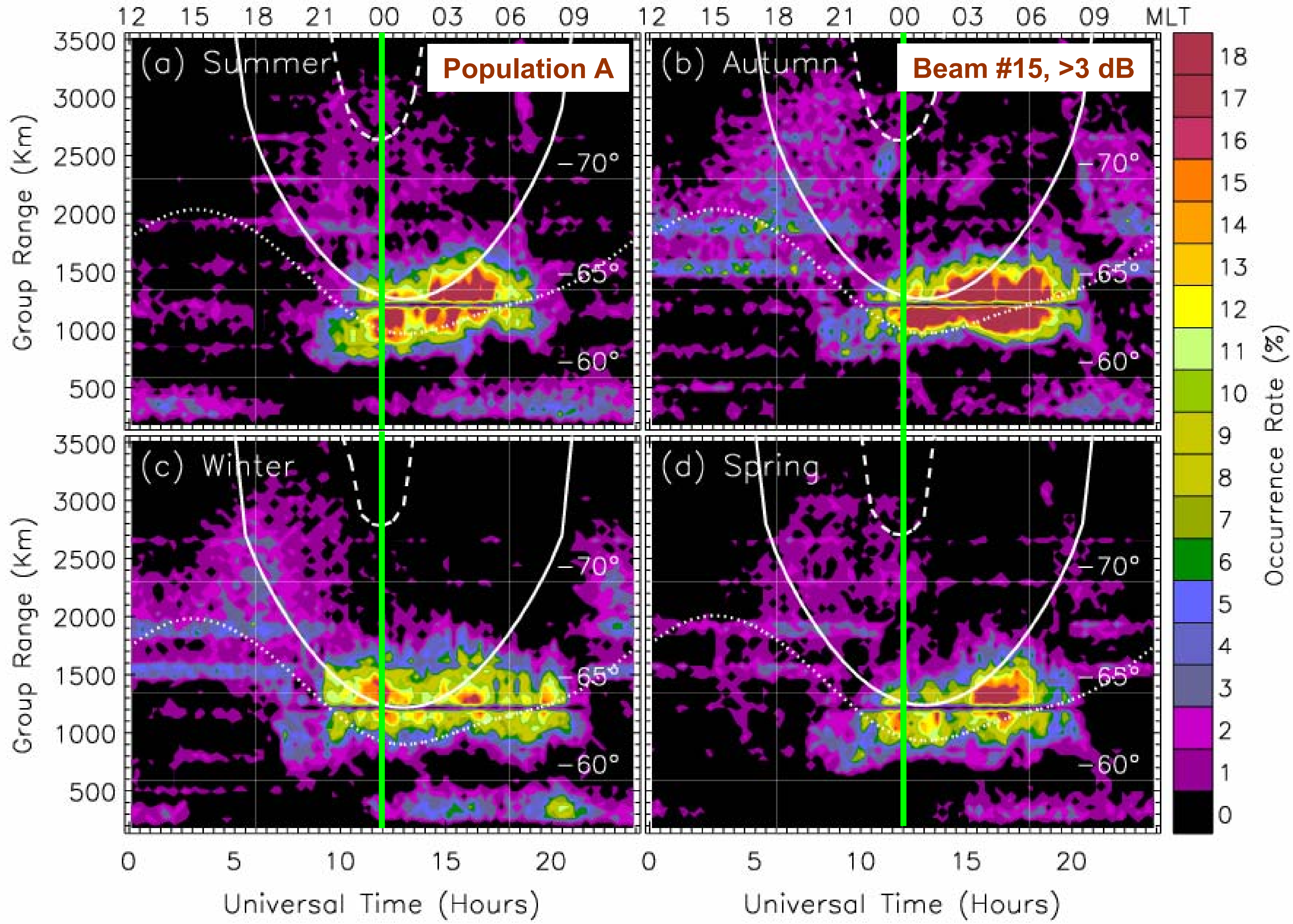
TIGER Tasmania Ionospheric Scatter, 13:22:57 UT, 10 December, 1999



TIGER Echo Occurrence, December 1999 to November, 2000

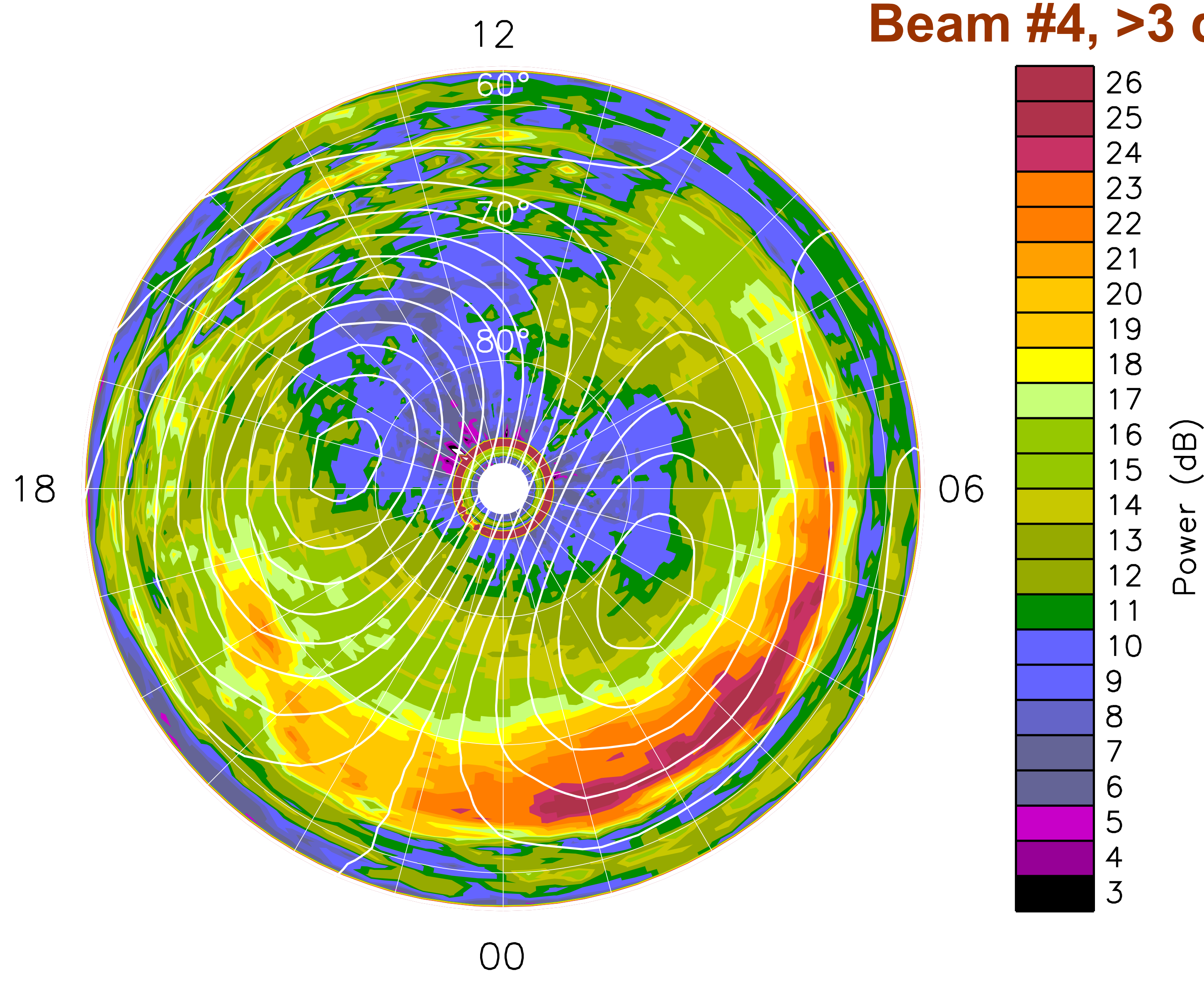


TIGER Echo Occurrence, December 1999 to November, 2000



TIGER Average FITACF Backscatter Power, December 1999 to November, 2000

Beam #4, >3 dB



Summary:

- **TIGER is ideally located to observe the formation of intense ionospheric irregularities just poleward of the nightside *O*pen-*C*losed magnetic field line *B*oundary (*OCB*):**

  (1) Traces of enhanced backscatter power tend to commence just poleward of the *OCB* where $\boldsymbol{E \times B}$ velocity transients occur frequently.

  (2) Statistics show more echoes with *SNR* >3 dB tend to be observed post-midnight on all beams of TIGER.

  (3) Without question, on average the backscatter powers are greatest post-midnight.

- **The important role of ionospheric "slip velocity" in gradient drift instability theory is consistent with stronger F-region irregularities observed by TIGER post-midnight.**
- **What other theories are consistent with these important TIGER observations?**