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The Tasman International Geospace Environment Radar I (TIGER I): Initial results and future directions

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TIGER Oz Research Topics:

1. Polar cap convection and noon-midnight responses.
2. The dynamics of ionospheric substorms.
3. Polarisation jets (PJs) and the main ionospheric trough.
4. The flow reversal boundary (FLR), sub-auroral drifts, and their penetration to mid-latitudes.
5. The occurrence of decametre-scale irregularities in the *F*-region.
6. Plasma instabilities in the *E*-region.
7. ULF wave activity and dynamics of the plasmapause.
8. The generation and propagation of atmospheric gravity waves (AGWs).
9. Polar mesospheric summer echoes (PMSEs).
10. Meteor astronomy and mesospheric winds, tides, and waves.
11. Radar oceanography using surface- and sky-wave propagation.

Seminar Synopsis:

1. **Nightside signatures of the open-closed magnetic field line boundary (OCB) and the effects of magnetic reconnection in the magnetotail.**

2. **The study of polarisation jets (PJ) or sub-auroral ion drifts (SAID) occurring in close association with substorms, and the subsequent formation & evolution of the main ionospheric trough.**

Morphology of the Nightside Magnetosphere

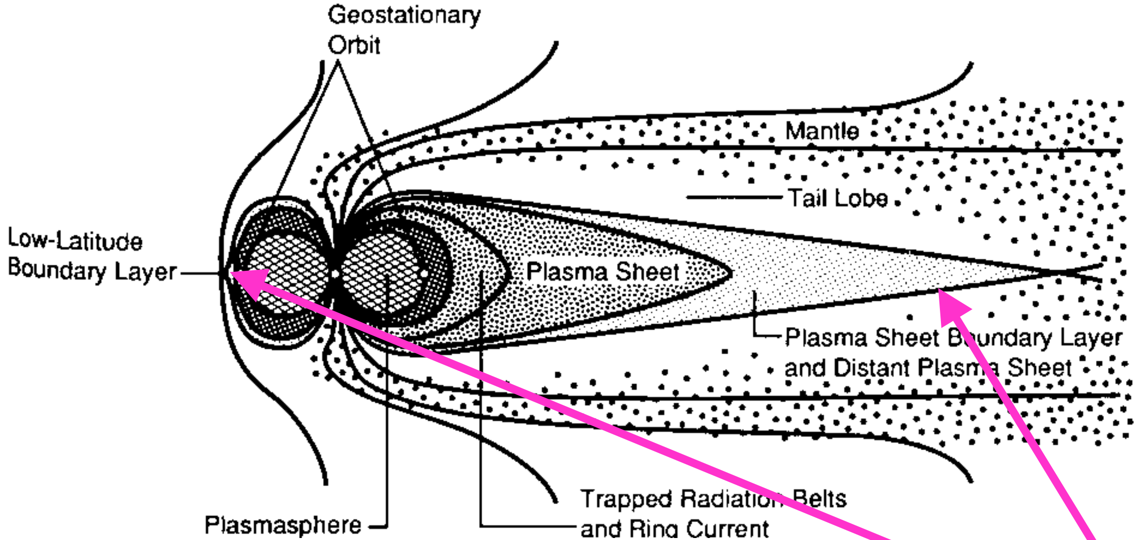
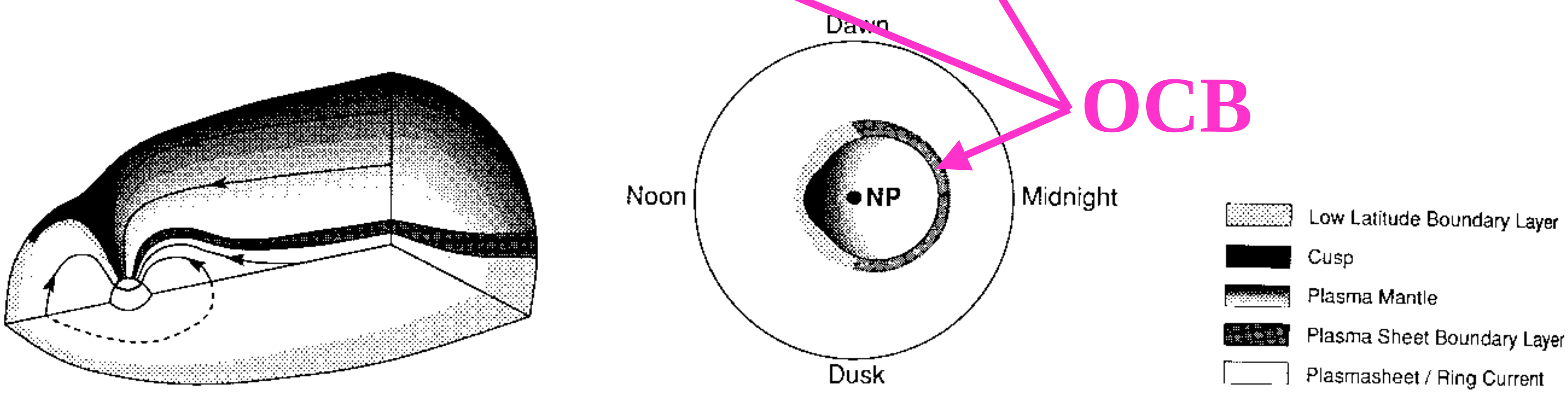


FIG. 10.4. Schematic diagram of plasma regions of the earth's magnetosphere as viewed in the noon–midnight meridian plane. The plasmasphere typically occupies much of the same region of space as the radiation belts. Frequently there is little or no gap between the inner edge of the plasma sheet and the outer boundary of the trapped radiation belts.



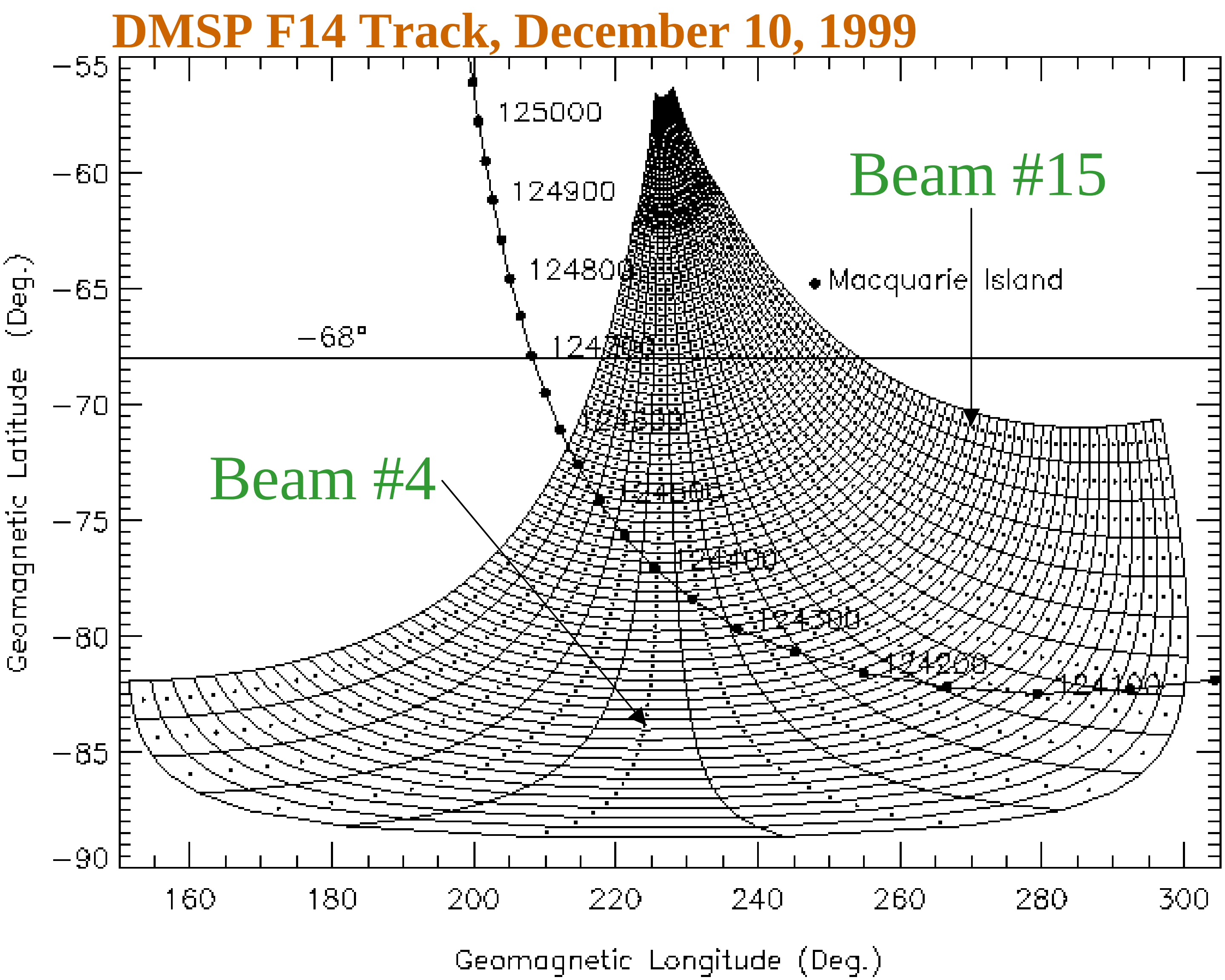
M. Kivelson & C. Russell (Eds.), *Introduction to Space Physics*, Cambridge Univ. Press, 1995

FIG. 9.18. (top) Polar projection of the magnetopause showing the types of magnetopause crossings observed by *HEOS 2*. Note how the observations of low-latitude boundary-layer plasma (open circles), entry-layer plasma (solid circles), and plasma mantle (triangles) divide into three distinct spatial regions on the magnetopause. (Adapted from Haerendel et al., 1978). (bottom) Vasyliunas's (1979) mapping of the plasma boundary layers down to the high-latitude ionosphere.

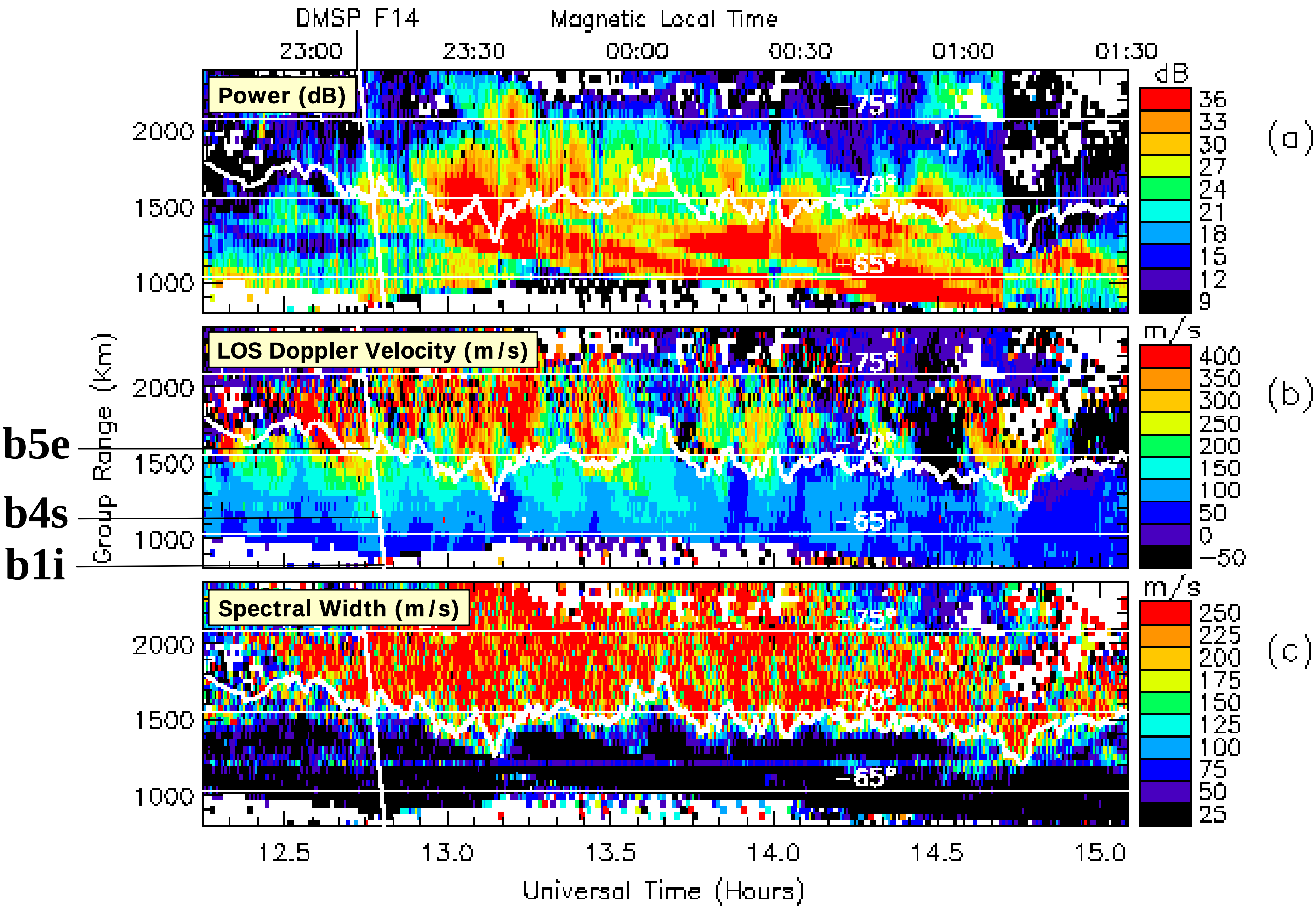
The Nightside SWB Problem:

- **Here we investigate the behaviour of a persistent, sharp spectral width boundary (SWB) located in the midnight sector near –69°Λ during 1215 to 1500 UT, 10 Dec. 1999.**
- **The SWB was observed using the TIGER SuperDARN radar in the "Z_TIGER99" mode. i.e., full scans with beam 4 soundings interlaced using 3-s integration times.**
- **Some particularly relevant studies:**
  - **Blanchard et al., *J. Geophys. Res.*, 102, 9697-9703, 1997**
  - **Lewis et al., *Ann. Geophysicae*, 15, 289-299, 1997**
  - **Dudeney et al., *Geophys. Res Lett.*, 25, 2601-2604, 1998**
  - **Yeoman et al., *J. Geophys. Res.*, 104, 14,867-14,877, 1999**
  - **Lester et al., *Ann. Geophysicae*, 19, 327-339, 2001**
  - **Woodfield et al., Submitted to *Ann. Geophysicae*, 2002**

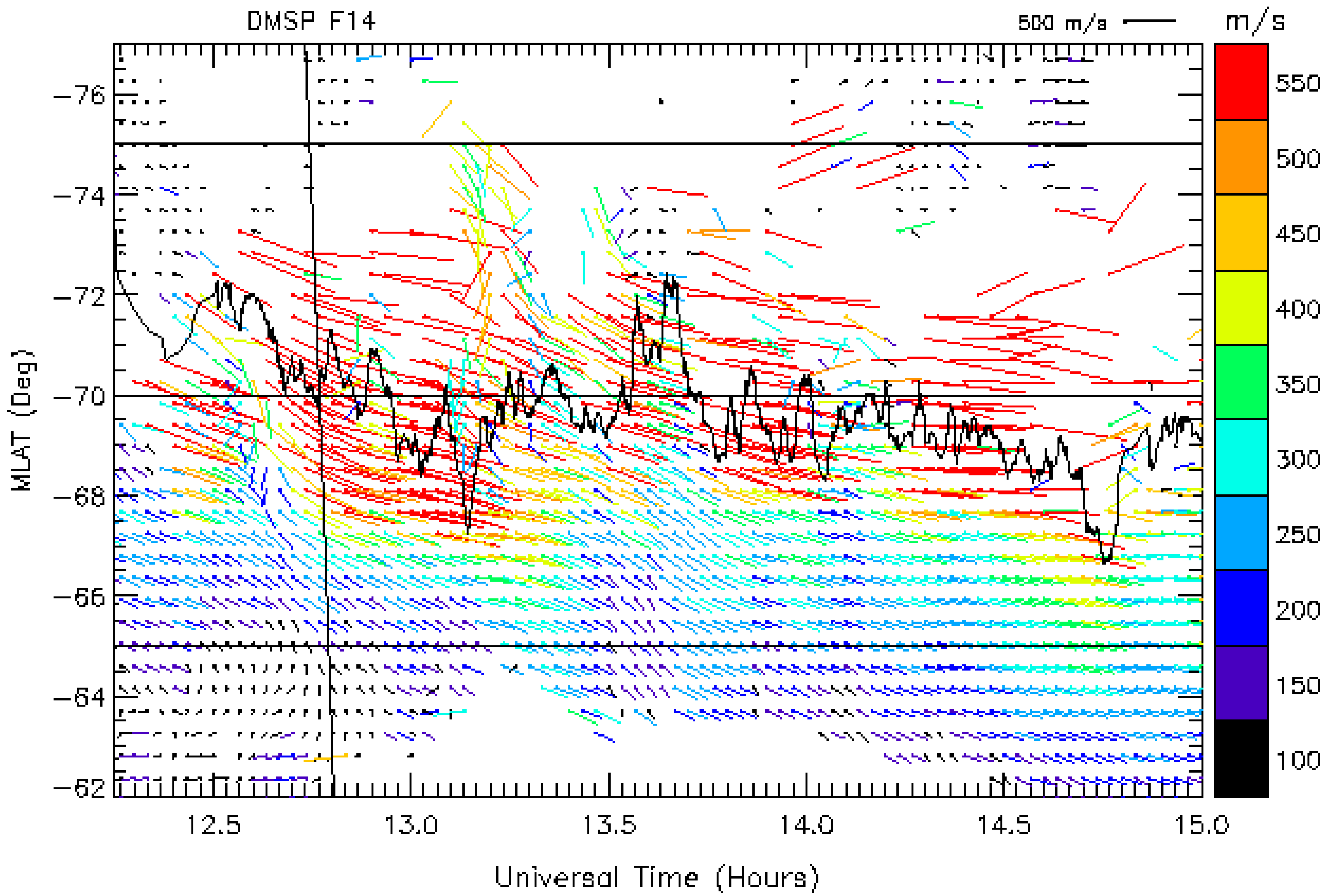
Space-Based Identification of Auroral Oval Boundaries



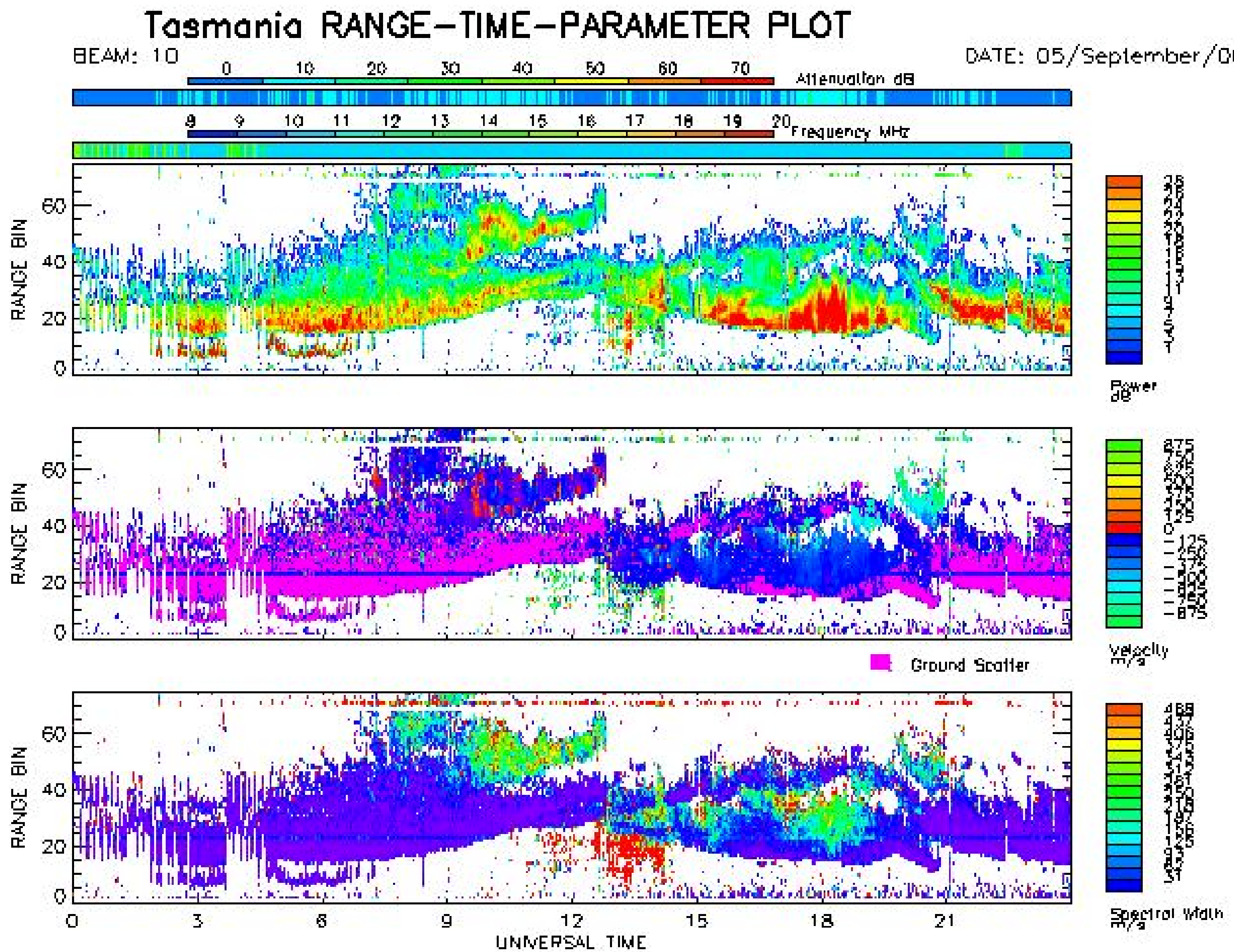
Range-Time Plot, TIGER Oz, Beam #4, 10 December, 1999



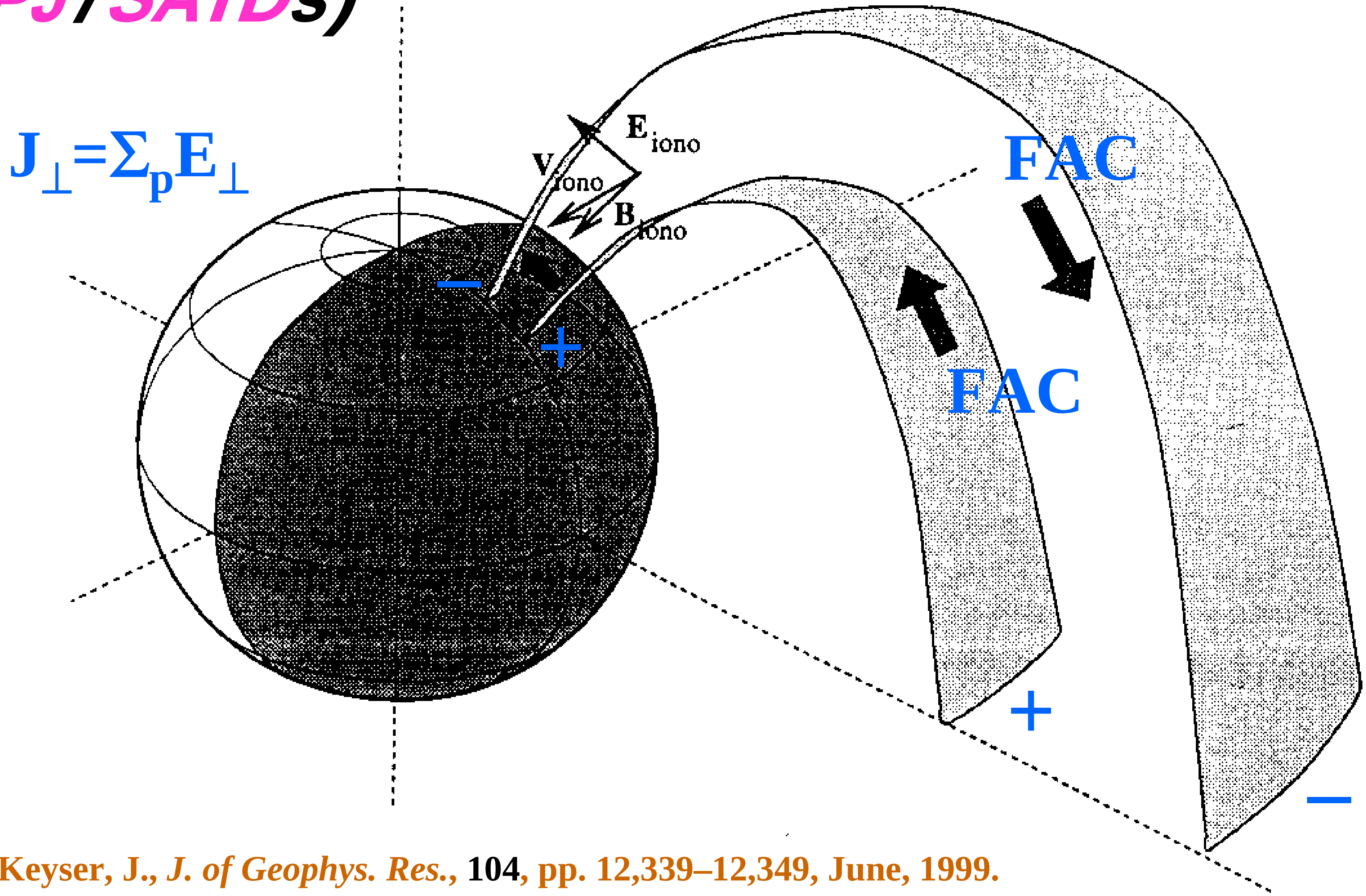
2-D Beam-Swinging Velocities, 10 December, 1999



New population of subauroral echoes produced by Pi 2-related ULF wave activity?



Polarisation Jets or Sub-Auroral Ion Drifts (PJ/SAIDs)



De Keyser, J., *J. of Geophys. Res.*, **104**, pp. 12,339–12,349, June, 1999.

Figure 1. Schematic view of the current sheet connecting the nightside ionosphere where a PJ/SAID is observed to the magnetosphere. The ionospheric magnetic field $\mathbf{B}_{iono}$ points down, the ionospheric drift $\mathbf{V}_{iono}$ is westward, and the electric field $\mathbf{E}_{iono}$ is directed poleward. The arrows indicate the direction of the field-aligned and ionospheric currents.

An Auroral Westward Flow Channel (AWFC)

Here we use TIGER Oz 1-min resolution, common mode observations, combined with ground-based magnetometer and DMSP satellite measurements to investigate:

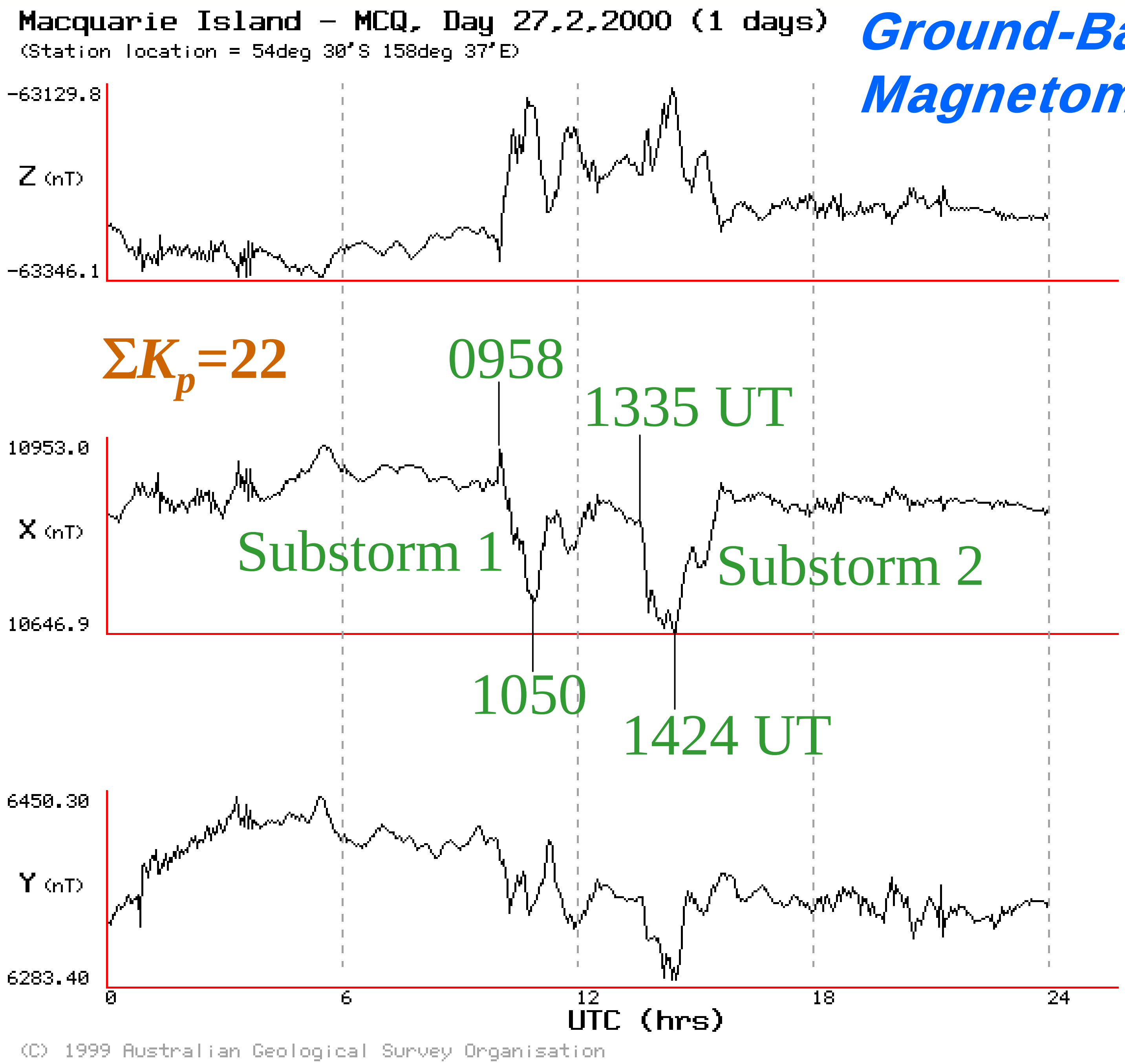
- **the behaviour of an ~2° wide *Auroral Westward Flow Channel* (*AWFC*) located near ~22 MLT and –65°Λ, and overlapping the equatorward edge of the auroral oval during ~0953 to 1110 UT on 27 February, 2000;**

- **its growth near the onset of a nearby –190-nT ionospheric substorm, and subsequent decay at the end of recovery phase;**

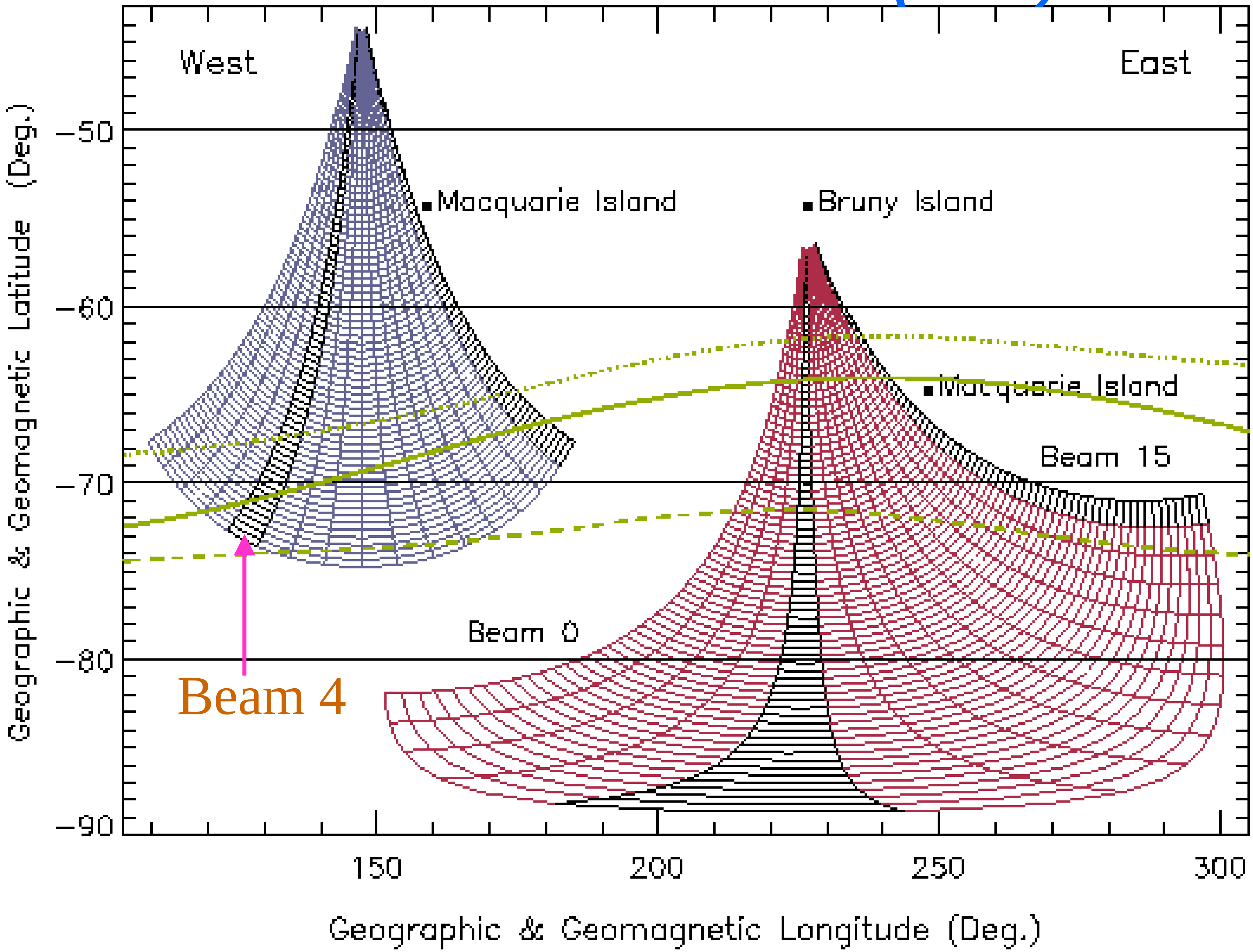
- **its similarity to a *Polarisation Jet* (*PJ*) or *Sub-Auroral Ion Drift* (*SAID*);**

- **a step-like increase (decrease) in the power (spectral) widths at the end of the main *AWFC*, and the subsequent appearance of narrow, trough-like spectral widths.**

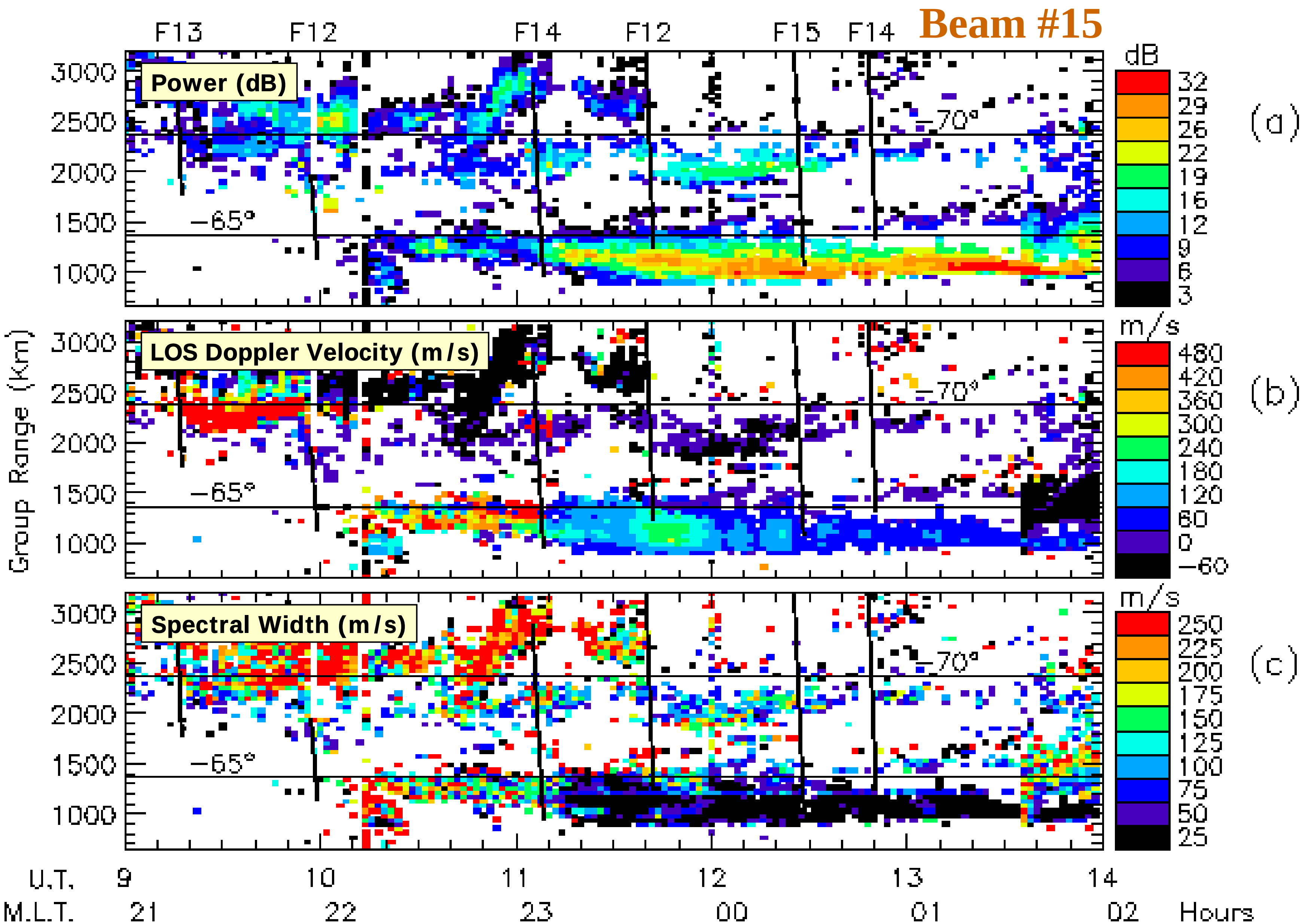
Ground-Based Magnetometer



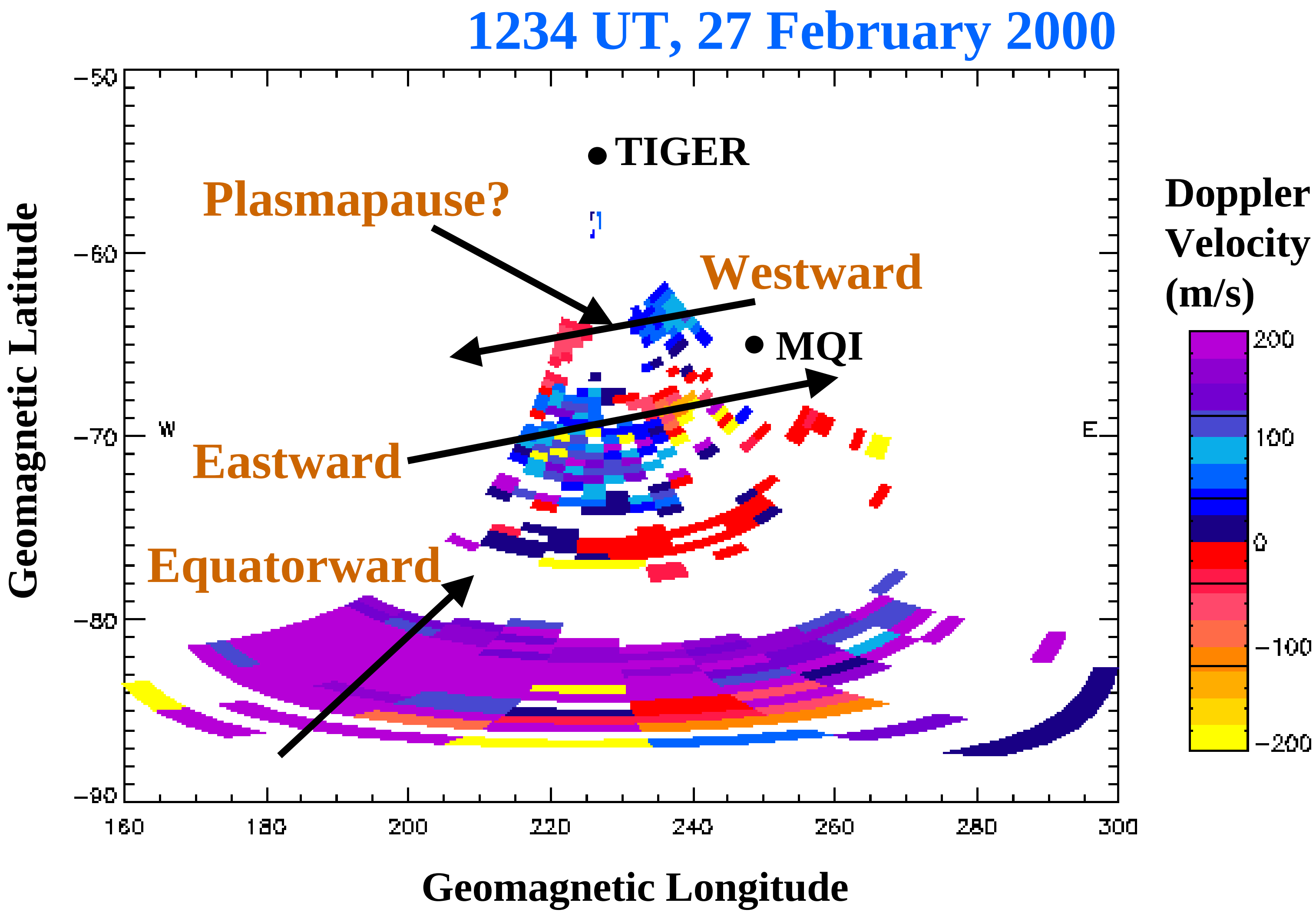
TIGER Oz Field of Views (FOVs)



Auroral Westward Flow Channel (AWFC), 27 Feb. 2000

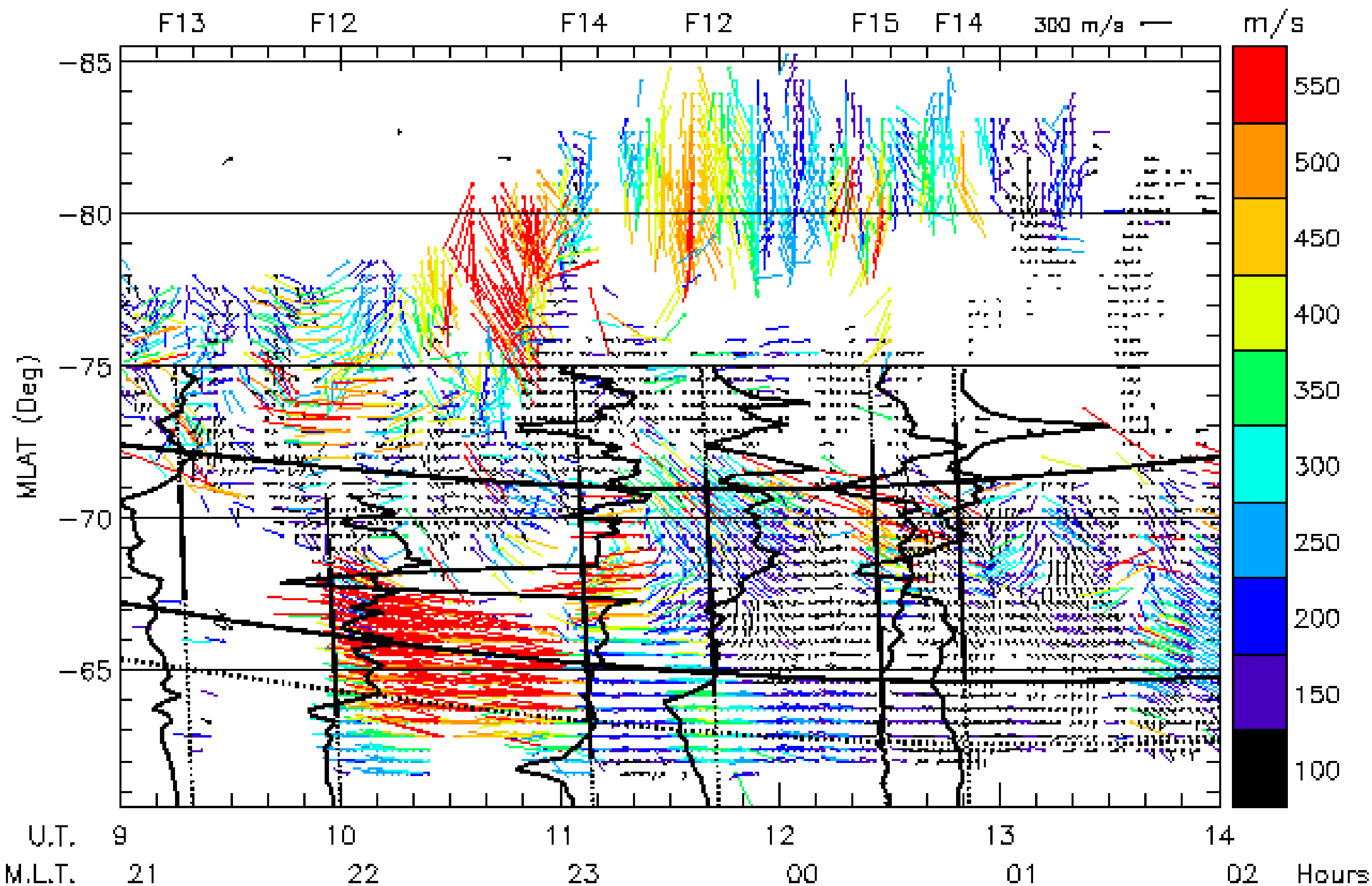


Sub-Auroral East-West Velocity Shear



Gradient drift waves, $\gamma \propto \mathbf{v} \cdot \nabla n_e / n_e$ *where* $\mathbf{v} = \mathbf{E} \times \mathbf{B} / B^2$

2-D Beam-Swinging Velocities, 27 February, 2000



Future Directions:

1. **Identify persistent, continuous scatter in the TIGER Oz and conjugate King Salmon radar FOVs during ionospheric substorms and specify their dynamics with improved clarity. Make use of coincident spacecraft data (e.g., Cluster) and the suite of supporting ground-based instruments at Macquarie Island.**

2. **Further studies of sub-auroral ion drifts (SAIDs) occurring in close association with ionospheric sub-storms, including their effects extending into the day-side ionosphere during large storms.**

3. **Use digital ionosondes and magnetometers to study the way changing high-latitude convection identified in the TIGER nightside scatter penetrates to mid-latitudes.**

Future Directions:

4. **Process the entire data base with beam-swinging analysis to facilitate a statistical study defining the behaviour of the velocity reversal boundary (VRB) separating high-latitude convection flows from co-rotational mid-latitude flows.**

5. **The overlapping FOV of TIGER NZ combined with a 20-dB increase in the gain of the radar pair will open up many possibilities for studying the "true" *2-D* convection at finer spatial and temporal resolutions (filamentary currents, small-scale vorticity, etc.)**

TIGER Observations of Leonids Meteor Storm, November 2001