

**La Trobe**  
UNIVERSITY

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*On the lifetime and extent of an  
Auroral **W**estward **F**low **C**hannel  
(**AWFC**) observed during a  
magnetospheric substorm*

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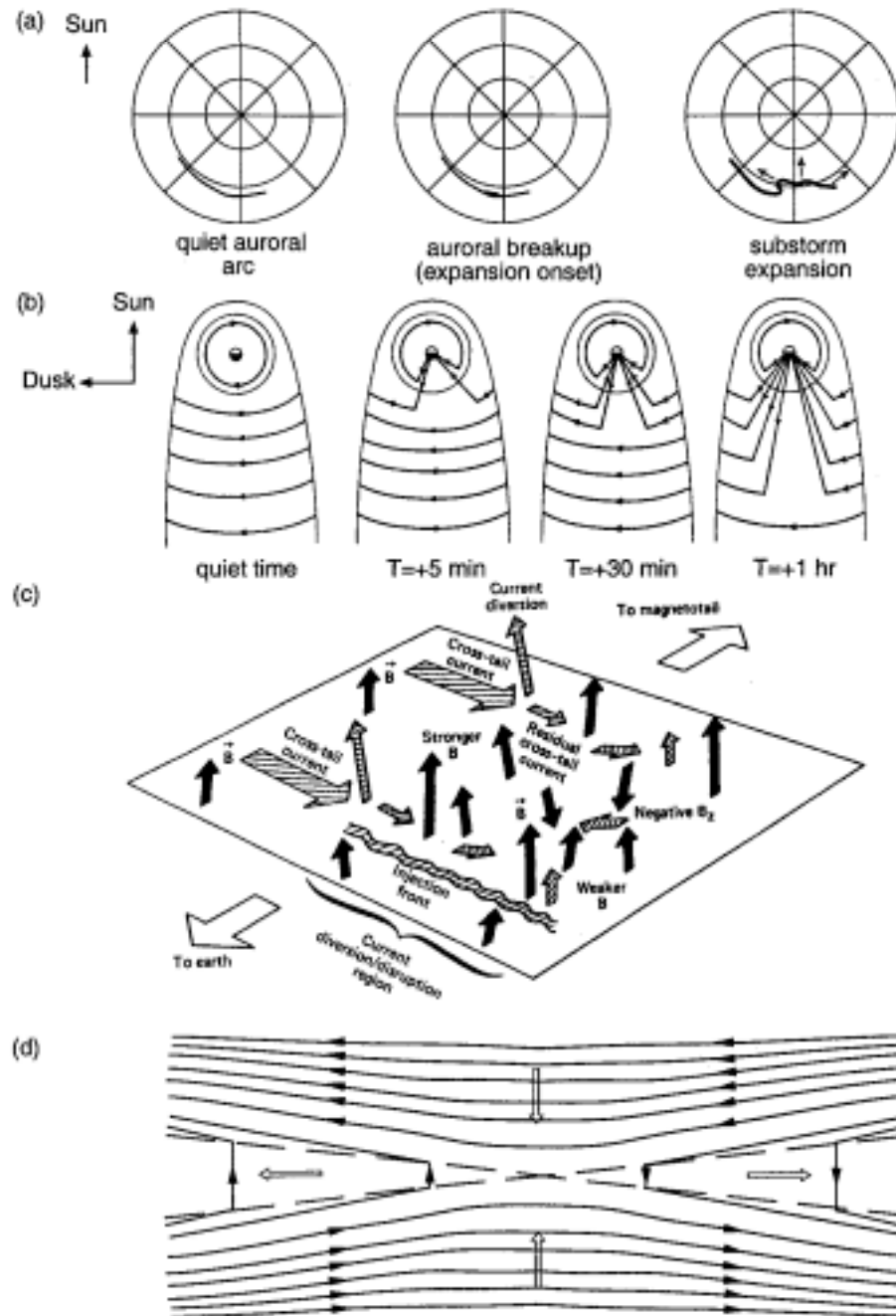
**(5) Australian Antarctic Division, Kingston, Tasmania 7050, Australia**

**(6) Department of Physics, University of Newcastle, New South Wales 2038**

# *What's this talk about?*

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  $\sim 2^\circ$  wide *Auroral Westward Flow Channel (AWFC)* located near  $\sim 22$  MLT and  $-65^\circ \Lambda$ , and overlapping the equatorward edge of the auroral oval during  $\sim 0953$  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.



## *The Magnetospheric Substorm*

Lui, A. T. Y., Current controversies in magnetospheric physics, *Reviews in Geophysics*, **39**, pp. 535–563, November, 2001.

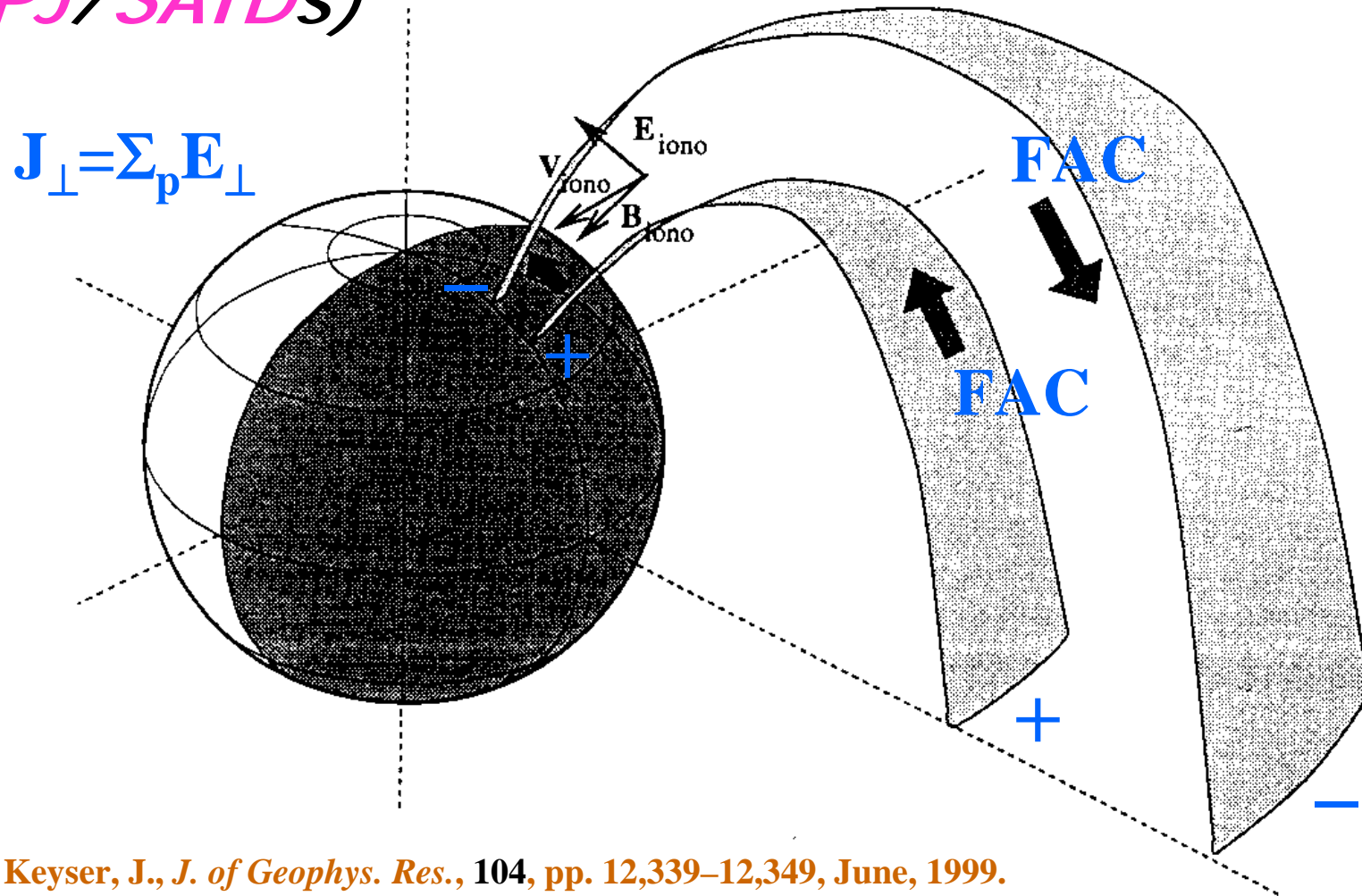
(a) Global auroral distribution.

(b) Electric currents in the equatorial plane.

(c) Plasma turbulence arising from current disruption.

(d) Magnetotail magnetic reconnection geometry.

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

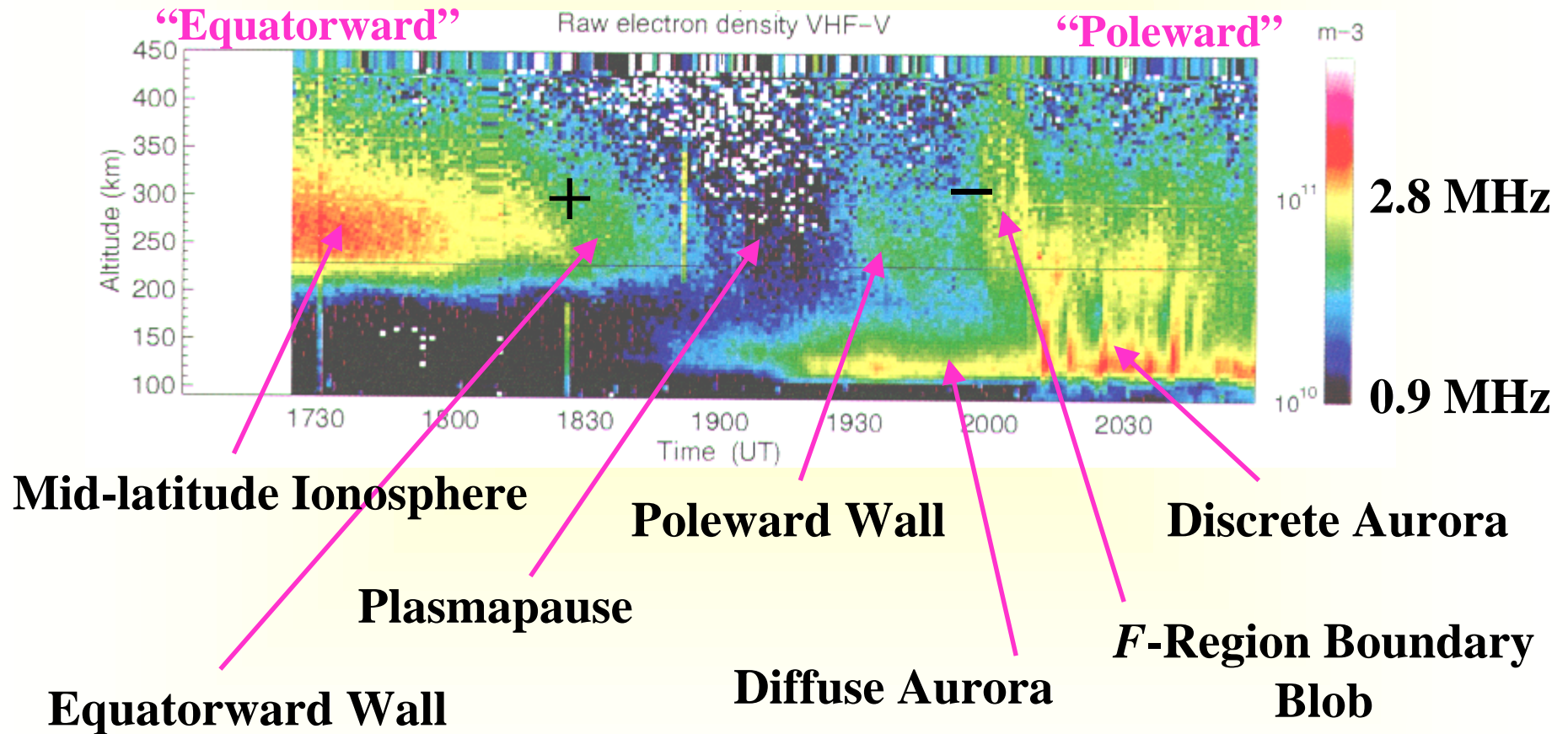


De Keyser, J., *J. of Geophys. Res.*, 104, pp. 12,339–12,349, June, 1999.

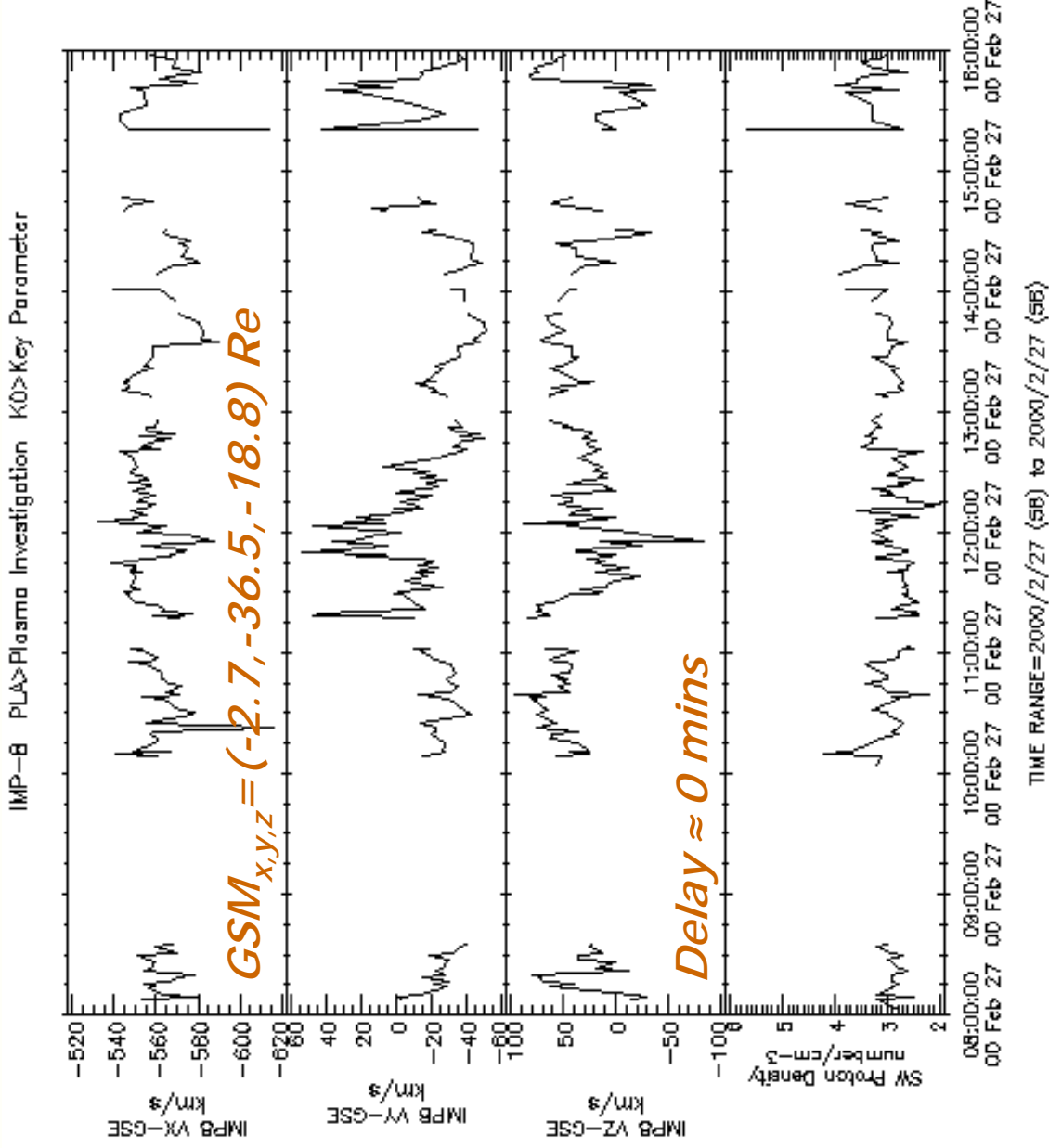
**Figure 1.** Schematic view of the current sheet connecting the nightside ionosphere where a PJ/SAID is observed to the magnetosphere. The ionospheric magnetic field  $B_{\text{iono}}$  points down, the ionospheric drift  $V_{\text{iono}}$  is westward, and the electric field  $E_{\text{iono}}$  is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

# Morphology of the Main Ionospheric Trough

EISCAT Electron Density (VHF-V) from Hedin *et. al.*, *Adv. Polar Upper Atmos. Res.*, **14**, 157–162, 2000.



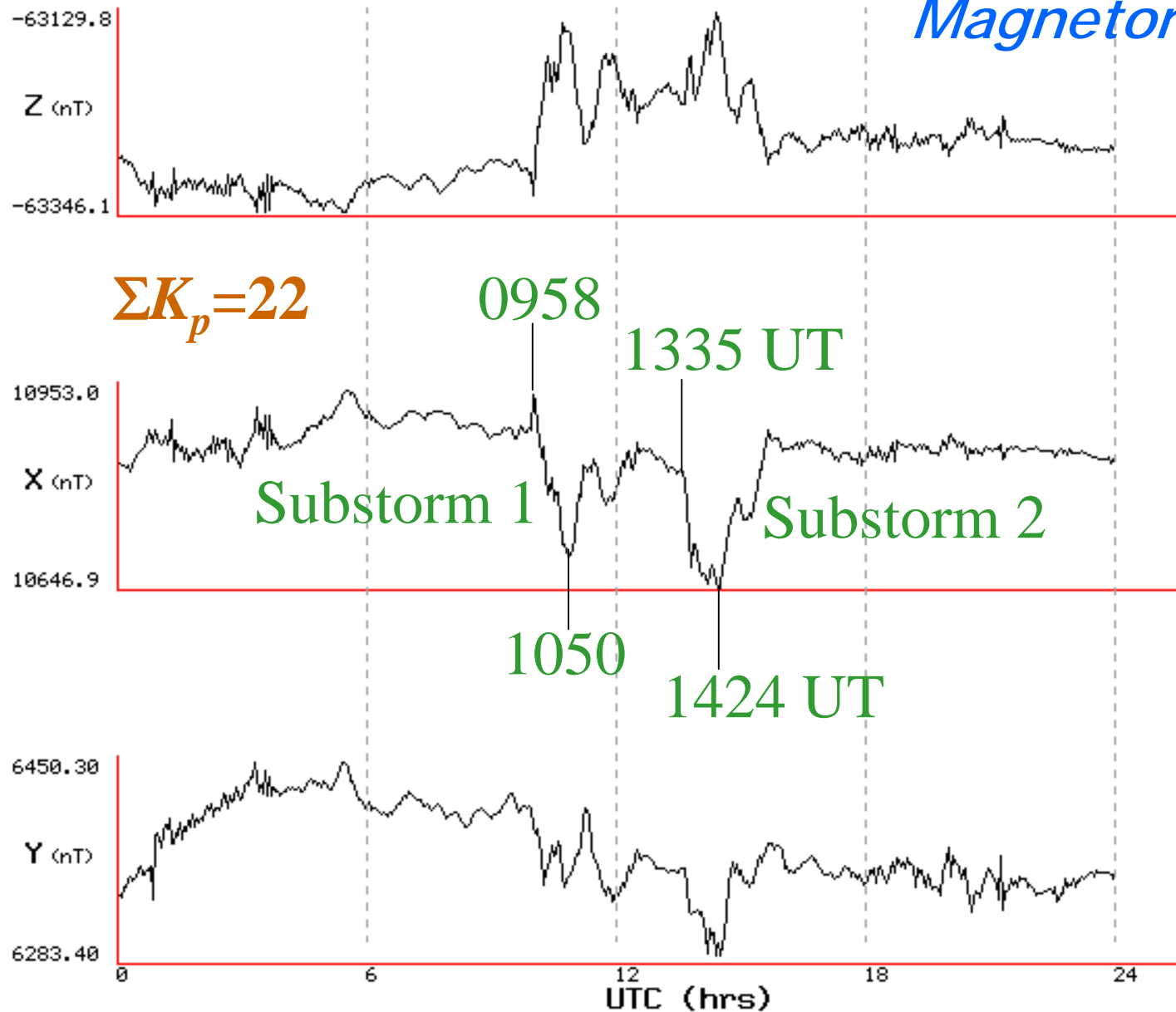
# Solar-Wind Conditions, IMP8 Satellite



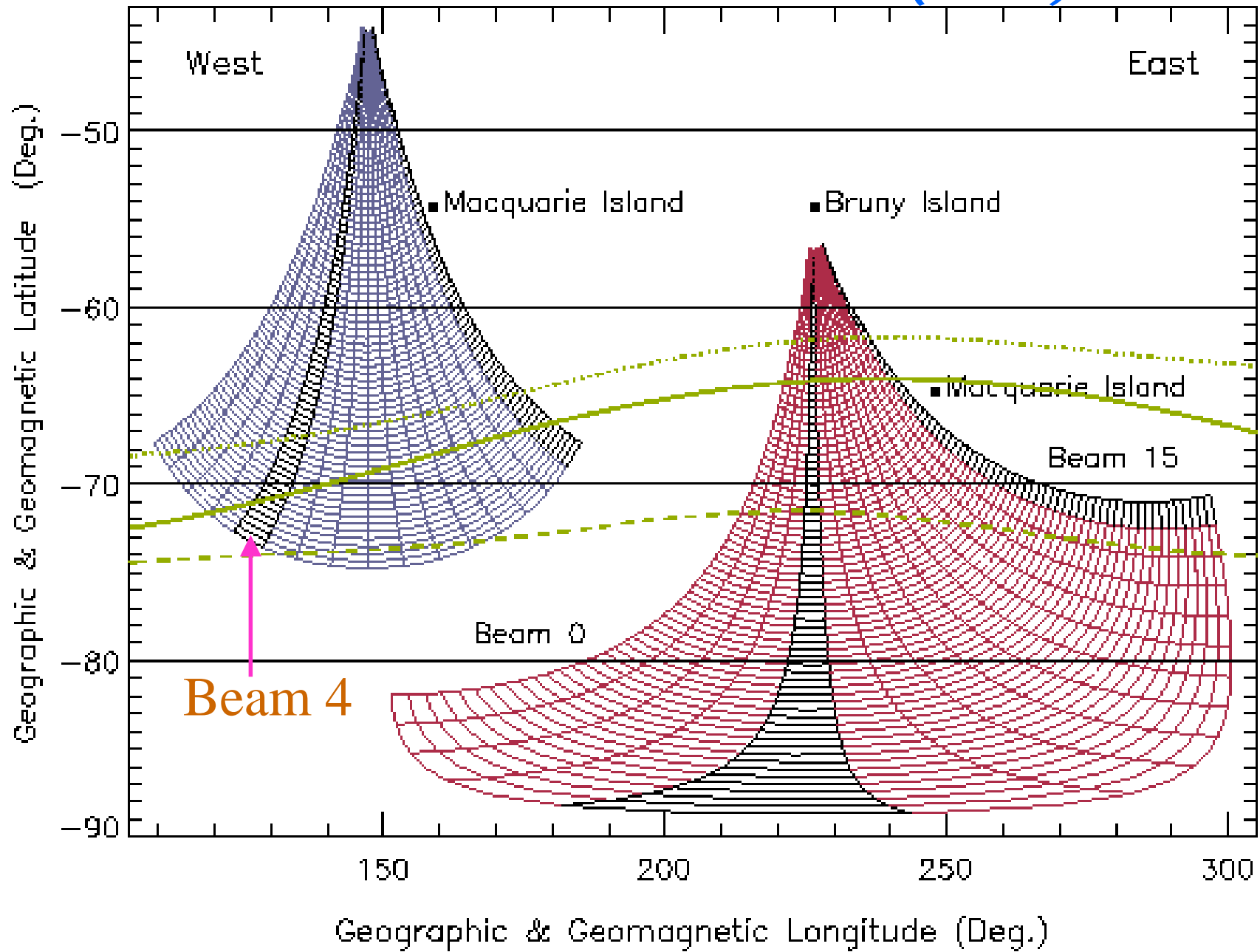
Please acknowledge data provider, A. Lazarus at MIT and CDAWeb when using these data.  
Key Parameter and Survey data (labels K0,K1,K2) are preliminary browse data.  
Generated by CDAWeb on Wed Mar 27 18:34:51 2002

Macquarie Island - MCQ, Day 27, 2, 2000 (1 days)  
(Station location = 54deg 30'S 158deg 37'E)

*Ground-Based  
Magnetometer*

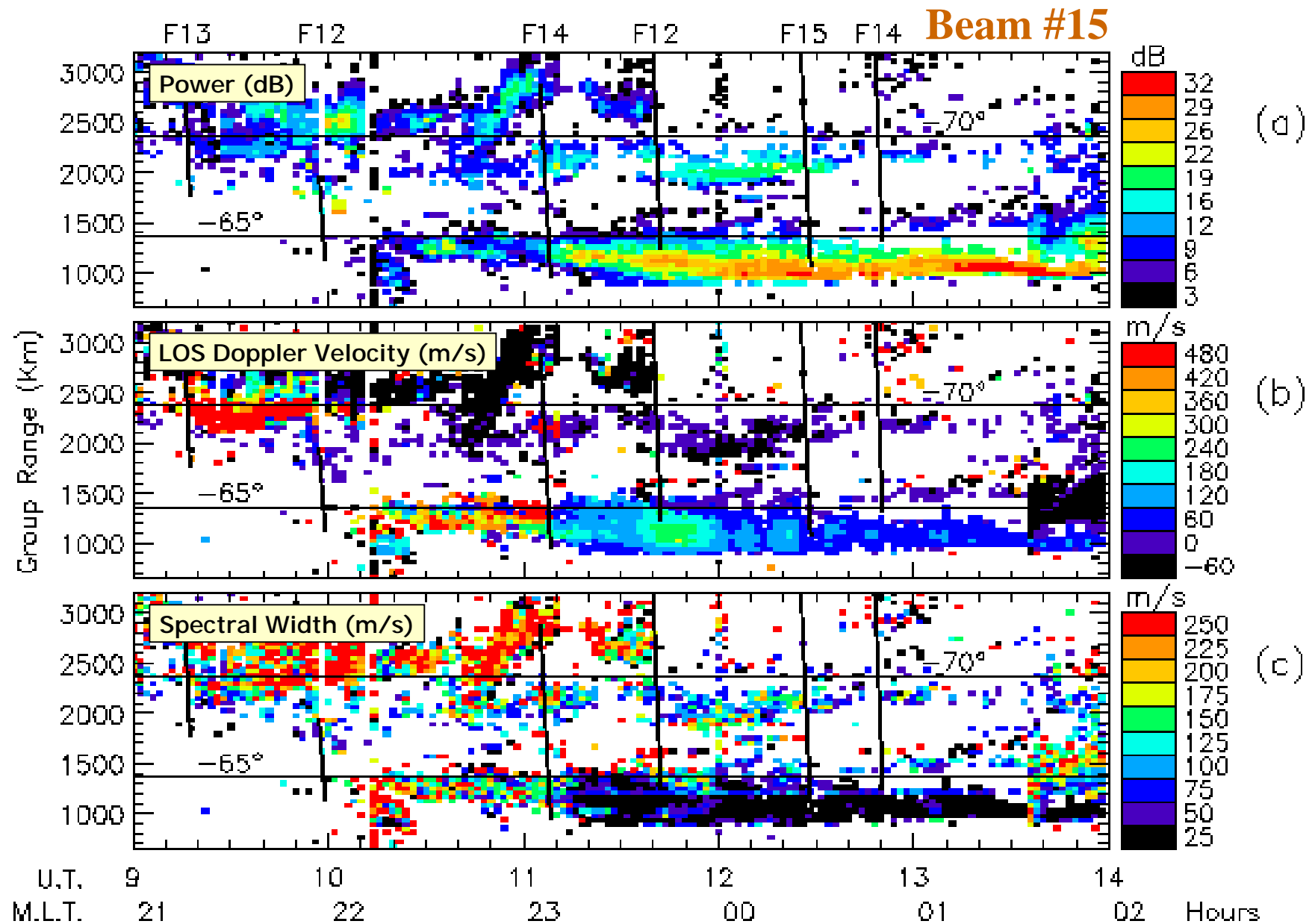


# TIGER Oz Field of Views (FOVs)



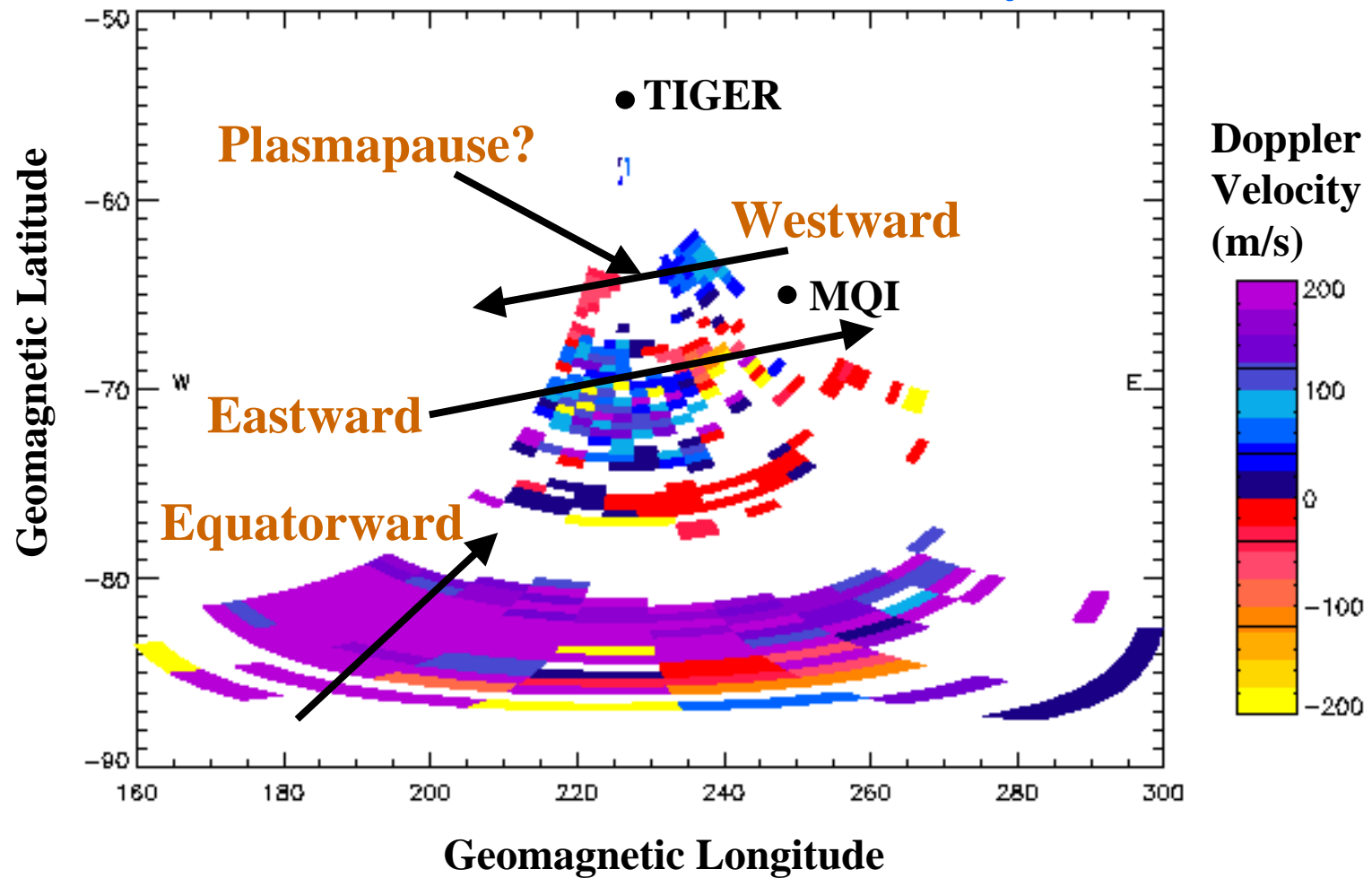


# Auroral Westward Flow Channel (AWFC), 27 Feb. 2000



# Sub-Auroral East-West Velocity Shear

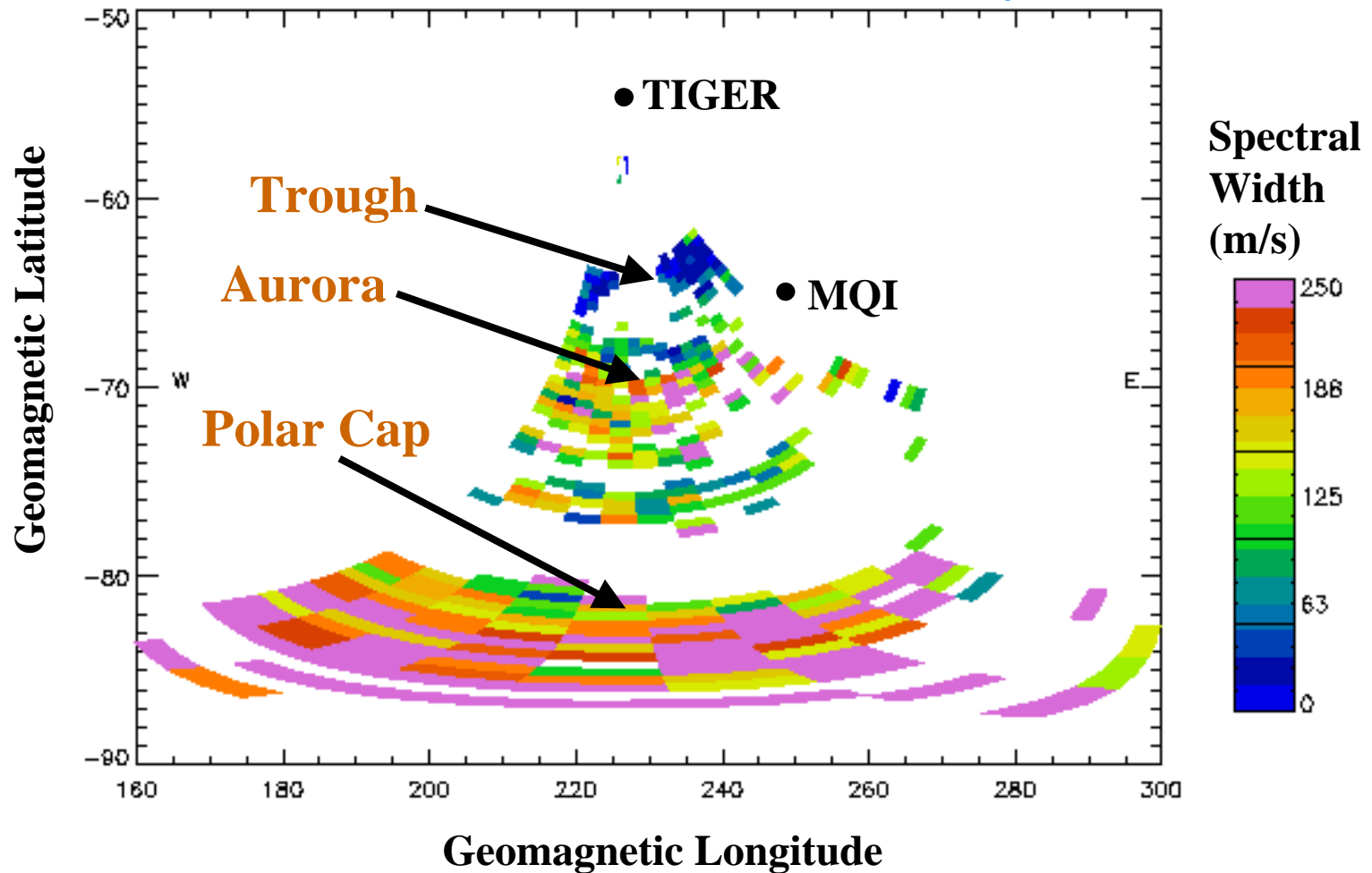
1234 UT, 27 February 2000



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

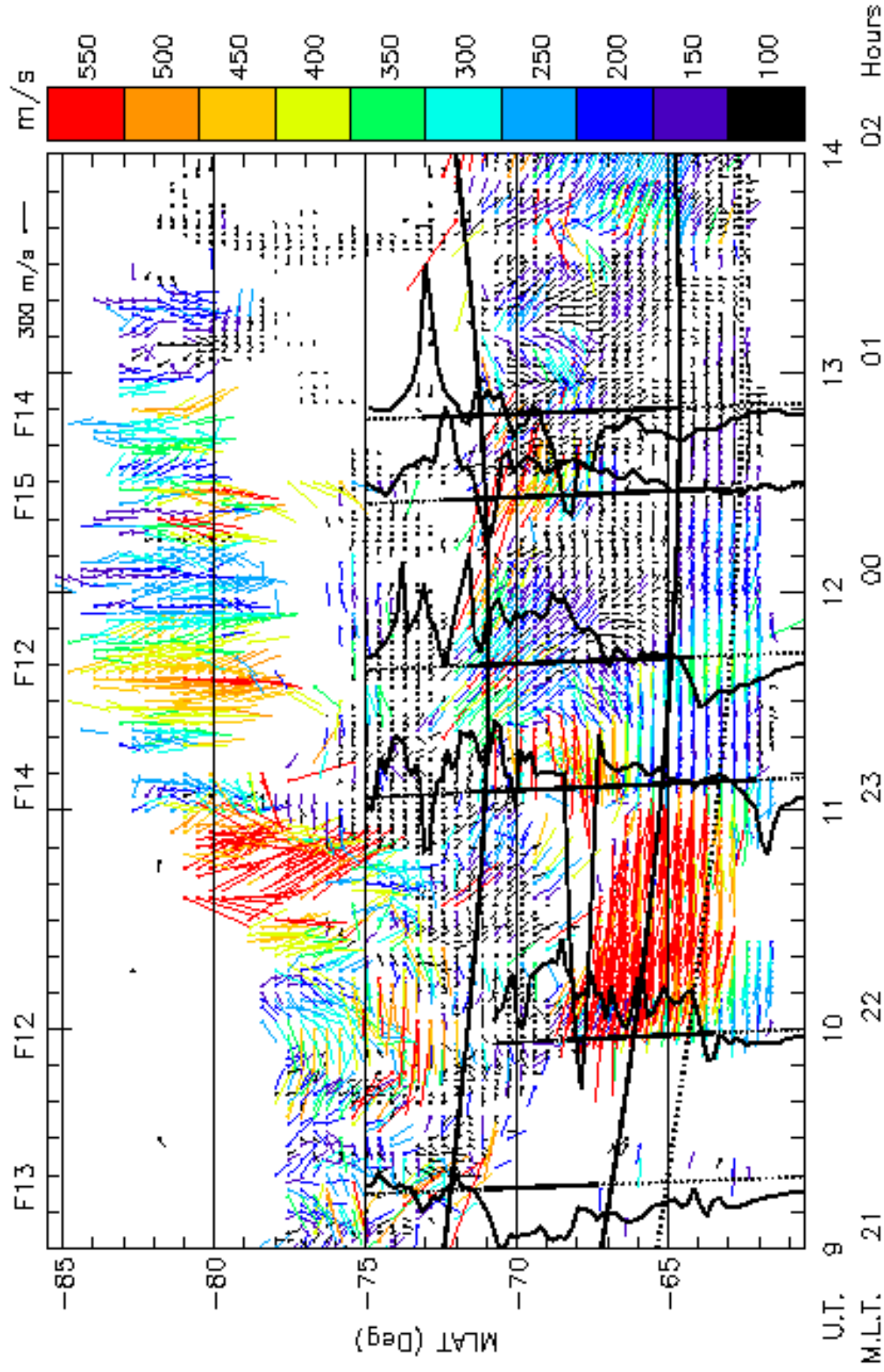
# *Sub-Auroral Trough-Like Spectral Widths*

1234 UT, 27 February 2000

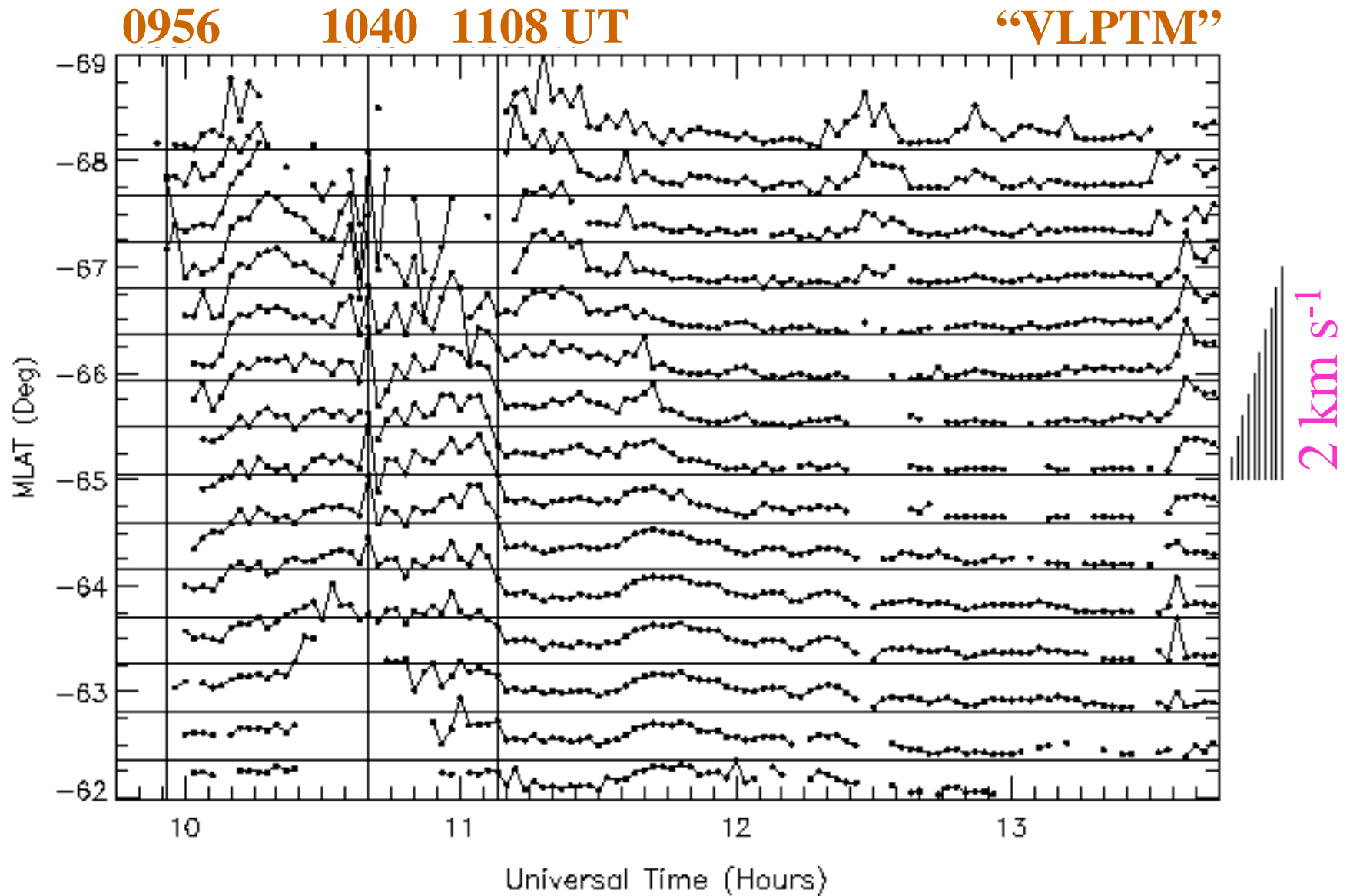


*Gradient drift waves,  $\gamma \propto \mathbf{v} \cdot \nabla n_e / n_e$  where  $\mathbf{v} = \mathbf{E} \times \mathbf{B} / B^2$*

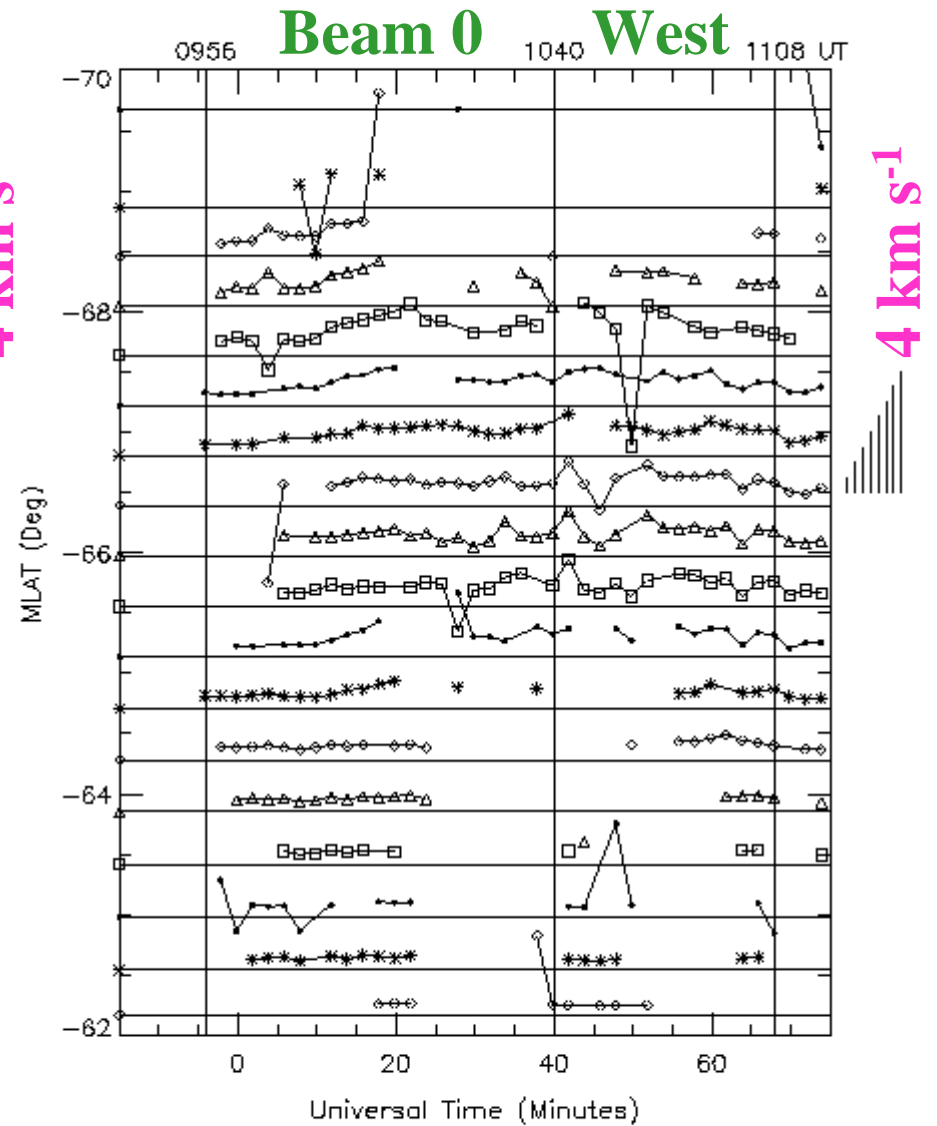
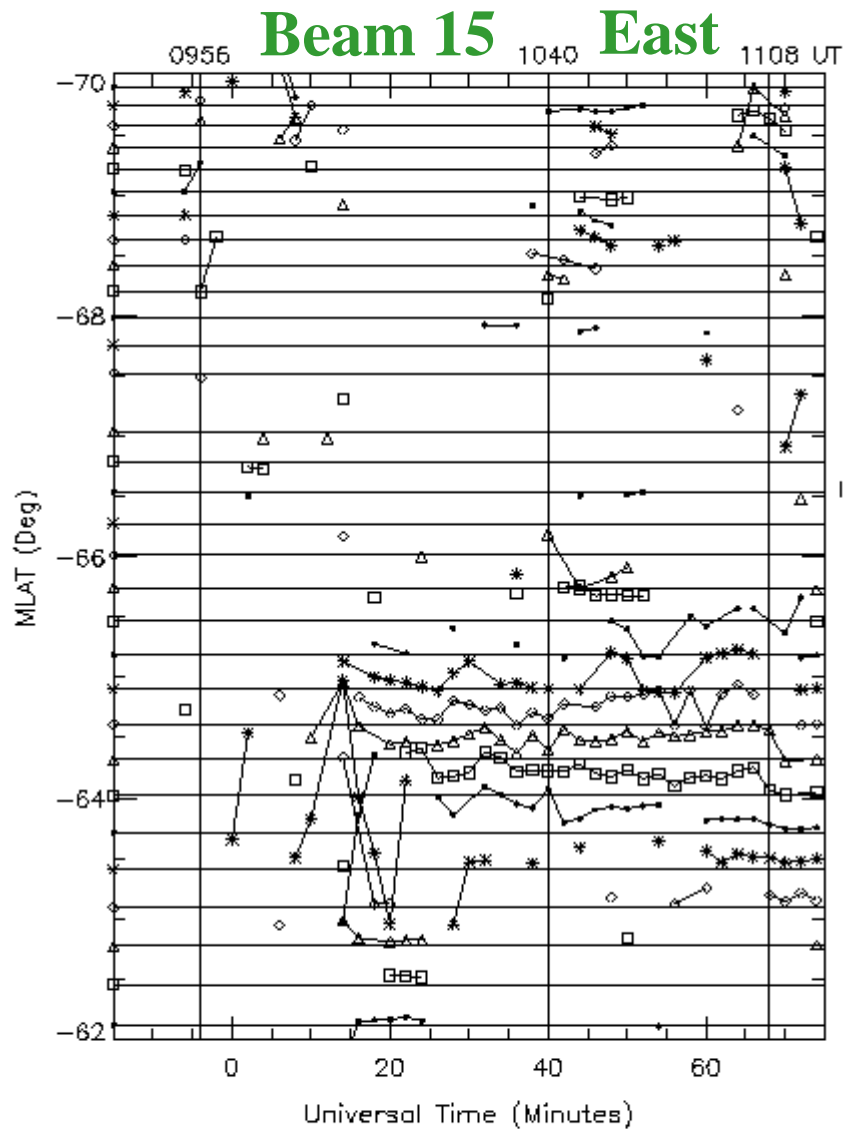
# 2-D Beam-Swinging Velocities, 27 February, 2000



# 2-D Beam-Swinging Speeds, 27 February, 2000

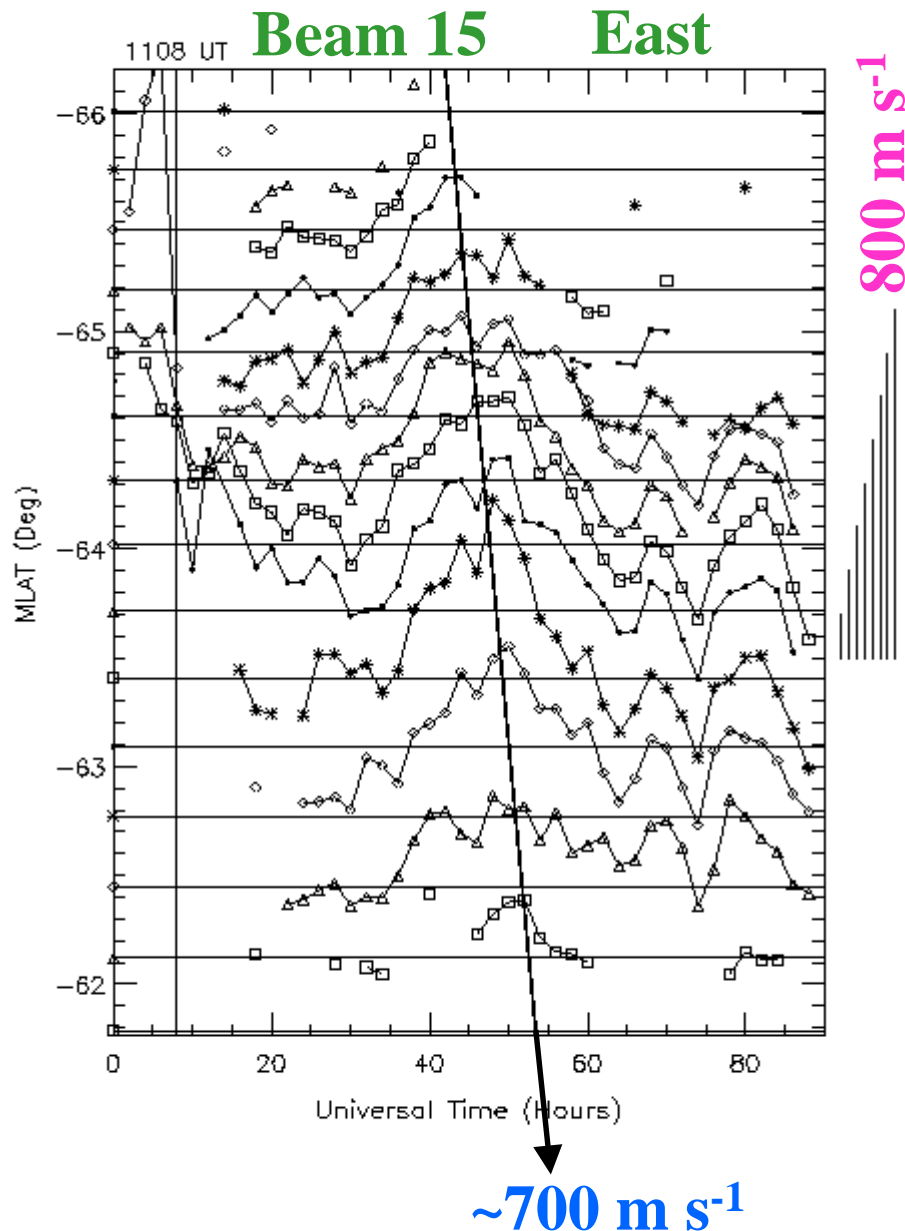


# Refined Beam-Swinging Analysis, 27 February, 2000



$$v_{w, i, j} = (v_{LOS\ i, j} - v_{eq}) / \sin(\theta_i - \varphi), \quad v_{eq} \approx 80 \text{ m s}^{-1}, \quad \varphi \approx 1^\circ$$

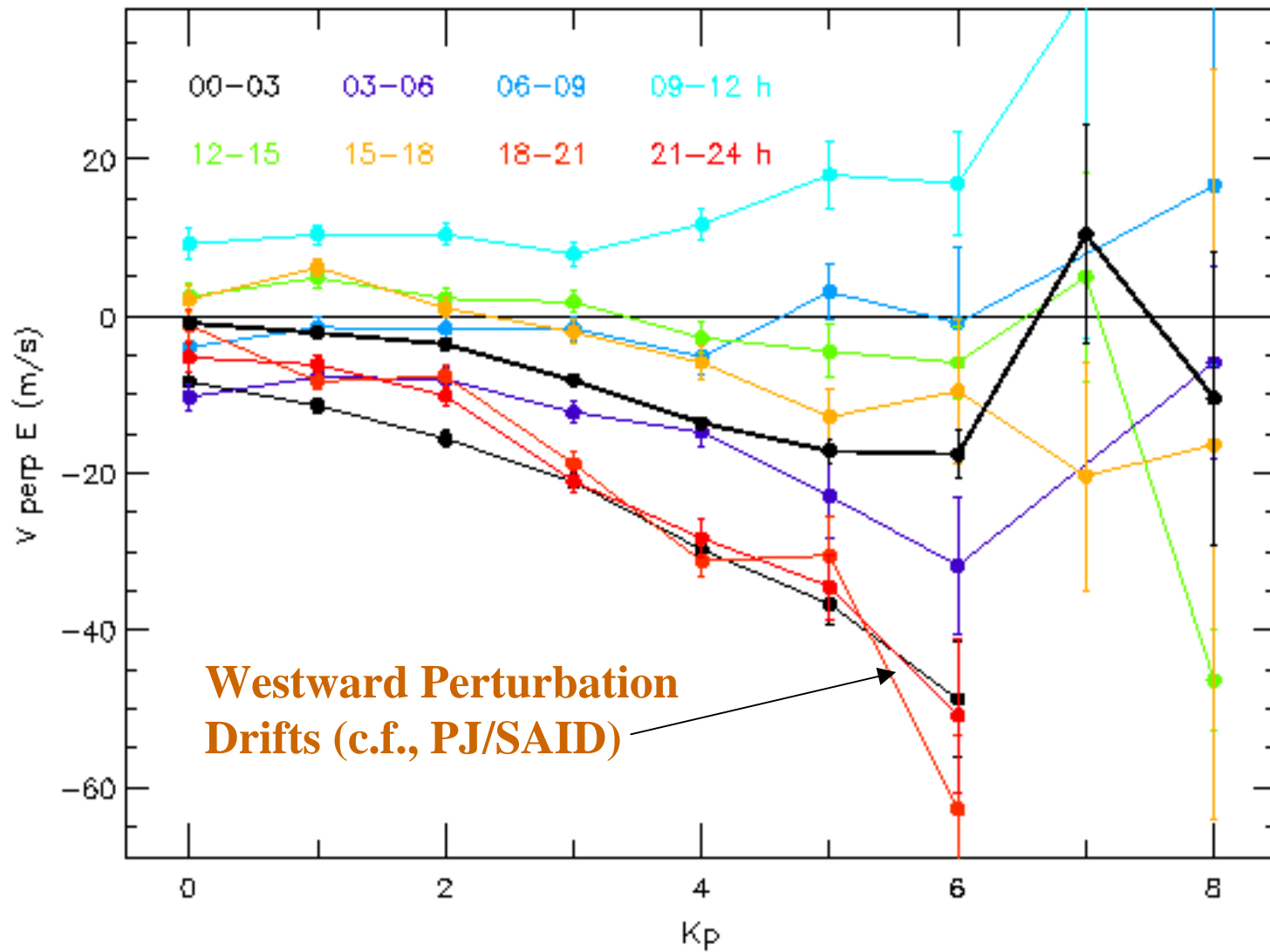
# Unexplained Westward Drift Expanding Equatorward



## Speculation:

1. Equatorward-propagating auroral disturbance?
2. For example, another minor AWFC?
3. Field-perpendicular electric field carried by AGW?
4. Prompt penetration or disturbance dynamo field propagating to mid-latitudes?
5. Any other ideas?

*Bundoora (37.7°S geo.; 49°S mag.)  
Digital Ionosonde Zonal Drifts*





## *Some Questions:*

- ◆ **Why was there no clear growth-phase signature before the onset of the storm?**
- ◆ **Why did our AWFC commence at substorm onset, yet PJ/SAIDs do not commence until during recovery phase?**
- ◆ **What caused the step-like change in the character of the ionospheric scatter at the end of the main AWFC?**
- ◆ **How many substorms are accompanied by PJ/SAID or AWFC, and under what conditions?**
- ◆ **Were the conditions of Substorm 1 specific to the requirements for the occurrence of an AWFC?**

## *Some More Questions:*

- ◆ **Are PJ/SAIDs, Substorm Associated Radar Auroral Surges (SARAS), Flux Depletion Regions (FDR) (Sanchez *et al.*, *J. Geophys. Res.*, 101, pp. 19,801–19,837, 1996), AWFC, prompt penetration fields, etc. all manifestations of the same, basic, underlying phenomenon?**
- ◆ **That is, was the AWFC an immature PJ/SAID?**
- ◆ **Was the ionosphere-magnetosphere feedback mechanism part of the process triggering the substorm?**
- ◆ **How does the response of the mid-latitude ionosphere change when there is a PJ/SAID?**