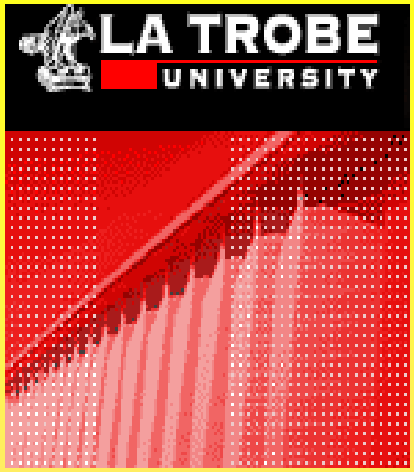
La Trobe University

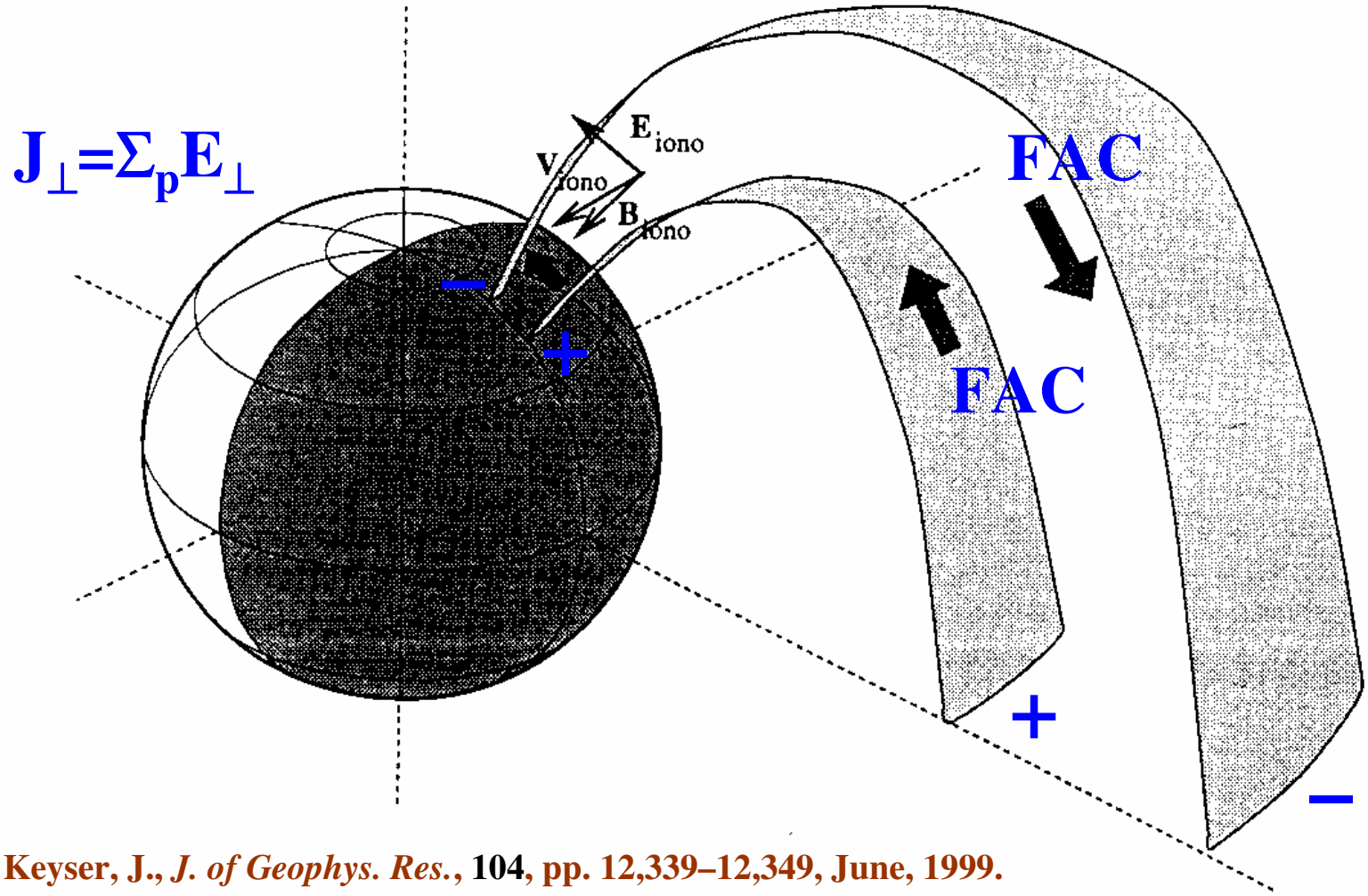


Magnetically conjugate Auroral Westward Flow Channels (AWFCs) observed by SuperDARN

M. L. Parkinson[1], M. Pinnock[2], J. A. Wild[3], M. Lester[3], T. K. Yeoman[3], S. E. Milan[3], H. Ye[1], J. C. Devlin[1], H.U. Frey[4], and T. Kikuchi[5]

(1) La Trobe University, Australia. (2) British Antarctic Survey, United Kingdom. (3) University of Leicester, United Kingdom. (4) Space Sciences Laboratory, University of California. (5) Communications Research Laboratory, Japan.

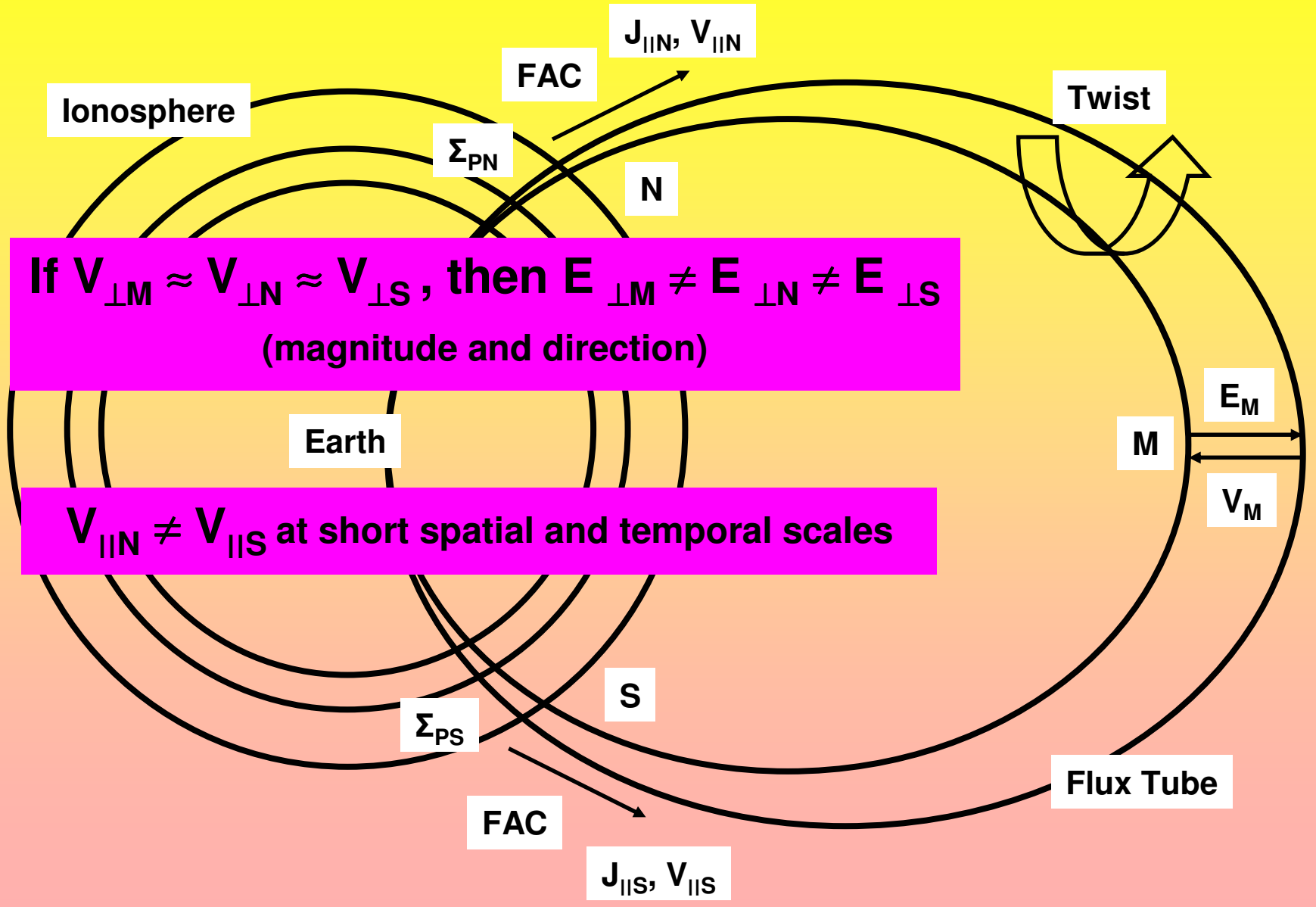
Polarisation Jets/Sub-Auroral Ion Drifts (PJ/SAIDs)



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.

Distortion of Magnetic Flux Tubes



Suppression of Small-Scale (<100 km) Electric Field Fluctuations in the Auroral Zone

Weimer et al, "Auroral zone electric fields from DE 1 and DE 2 at magnetic conjunctions," JGR, vol. 90, pp. 7479-7494, 1985.

Suppression of small-scale ionospheric electric fields where Σ_p is enhanced is consistent with earlier theory (Lyons, 1980, 1981; Chiu et al, 1981).

Dynamics Explorer (DE)

DE 1 > 4500 km

DE 2 < 900 km

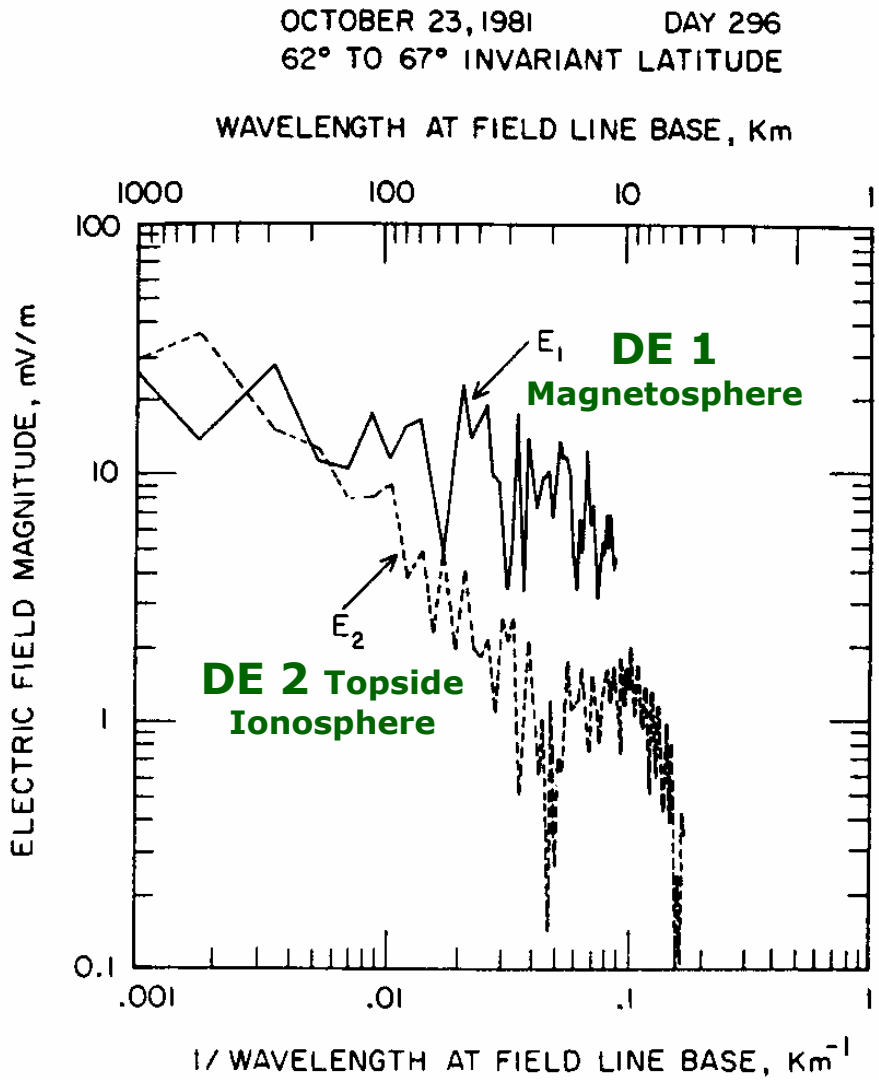


Fig. 4. Electric field spectrums from day 296 (October 23) of 1981. The spectrums are obtained from a Fourier transform of the electric field data between 62° and 67° invariant latitude. The solid line shows the spectrum of the electric field measured by DE 1. The solid line shows the spectrum of the electric field measured by DE 2. The ordinate values are obtained from the square root of the "spectral power density." The actual units are mV m^{-1} $km^{1/2}$.

Weimer et al, 1985

Starting Point:

In terms of electric field variations, *Auroral Westward Flow Channels* (*AWFCs*) are the strongest signatures of substorms in the ionosphere and inner magnetosphere. *AWFCs* are synchronised to the onset, expansion, and recovery of sub-storms. See: Parkinson et al., *Annales Geophysicae*, 21, pp 893-913, 2003.

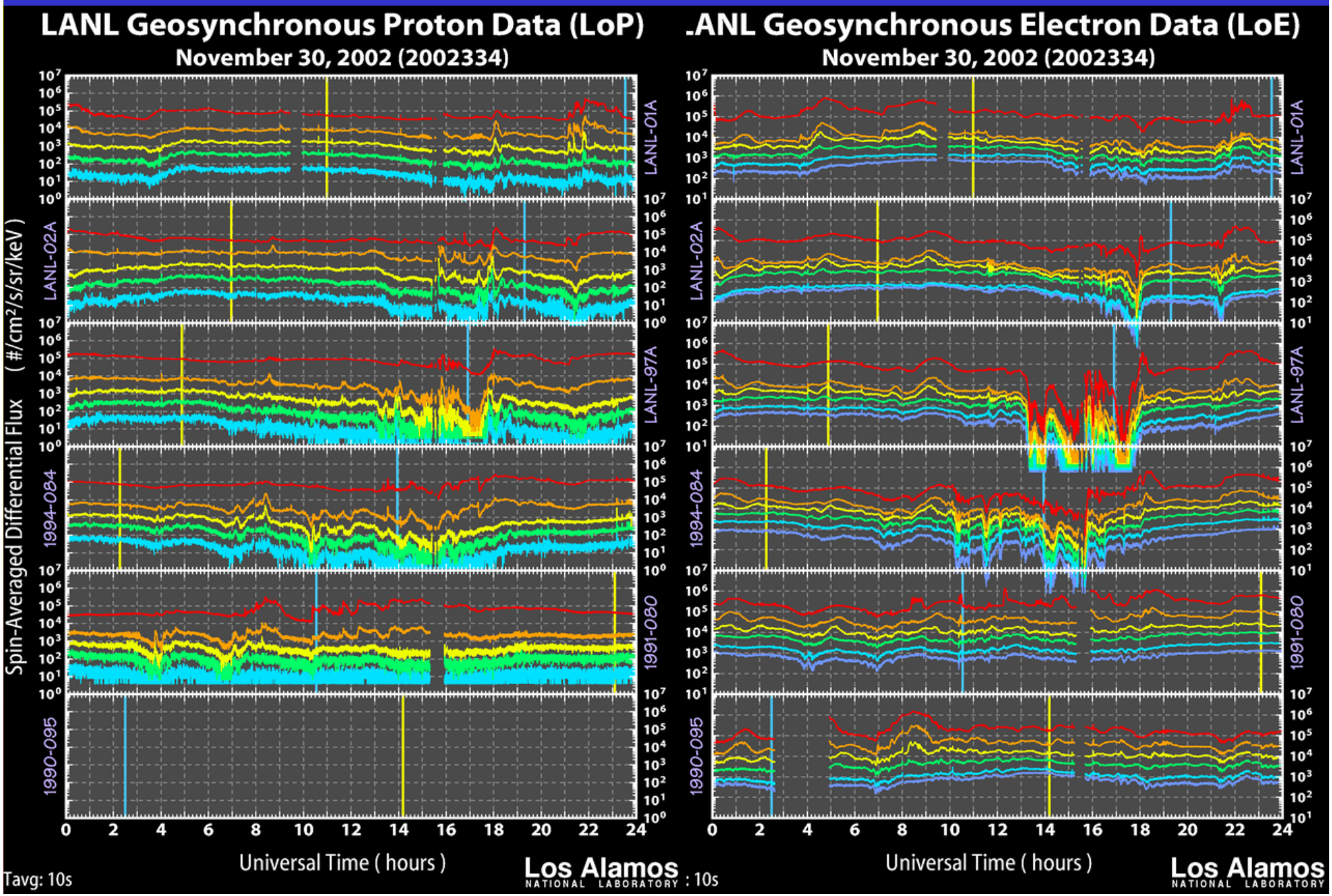
Aims:

- **To investigate the relationship between the injection of energetic electron and ions observed at geosynchronous orbit (*6.6 Re*), satellite measurements of auroral activity, ionospheric current flow measured by ground-based magnetometers, and *Super*DARN signatures of *AWFC* activity.**
- **To investigate similarities and differences between the characteristics of *AWFCs* observed at conjugate locations in the Northern and Southern Hemisphere. Are the magnetic field lines equi-potentials, or do we have to invoke anomalous field-aligned potential drops to explain the observed differences?**

Instruments:

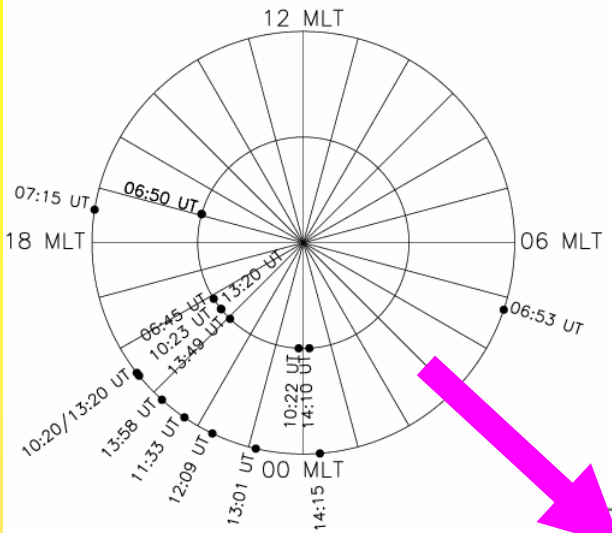
- **Geosynchronous orbit:** LANL Synchronous Orbit Particle Analyser (SOPA) measurements of "low energy" electron and proton flux (50 KeV to >50 MeV).
- **Auroral activity:** Imager for Magnetopause to Aurora Global Exploration (IMAGE): WIC FUV images of LBH N_2 emission bands. DMSP SS J/4 dynamic spectrograms of precipitating particles.
- **Ionospheric Hall current:** Macquarie Island fluxgate magnetometer (54.5°S, 158.9°E, 65°Λ).
- ***Super*DARN:** King Salmon (58.7°N, 203.4°E, 57°Λ) and the Tasman International Geospace Environment Radar (TIGER) (43.4 °S, 147.2°E, 55°Λ) radars.
- **Supplementary:** DMSP Special Sensor–Ions, Electrons, and Scintillation (SSIES) measurements of topside ion density and transverse ion drift velocity, V_y.

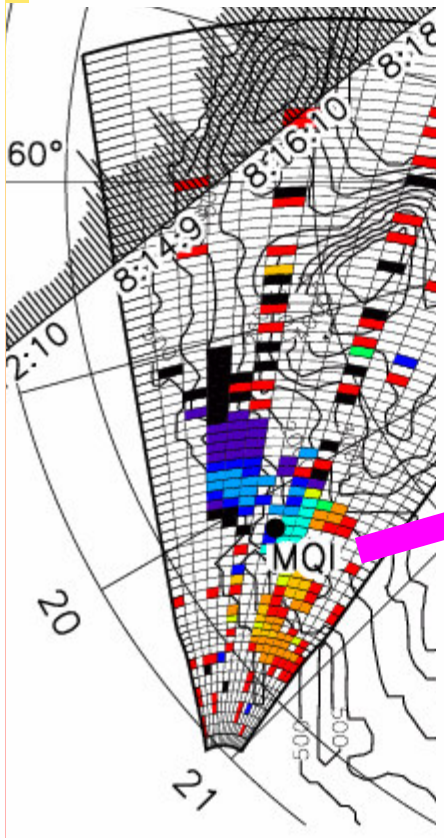
Energetic Particle Injections at Geosynchronous Orbit

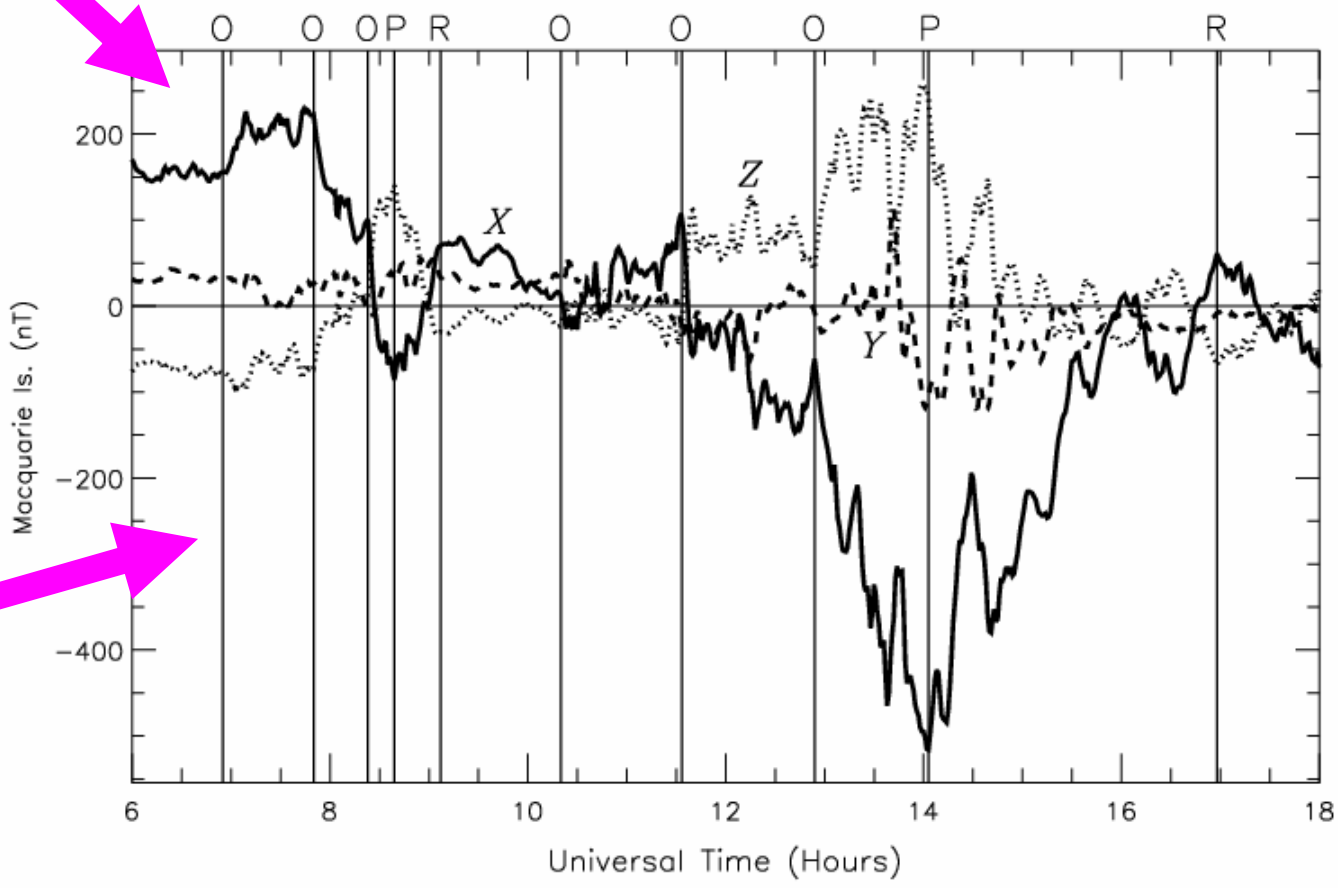


Left: ***LANL Energetic Particle Injection Times, 6.6 Re.***

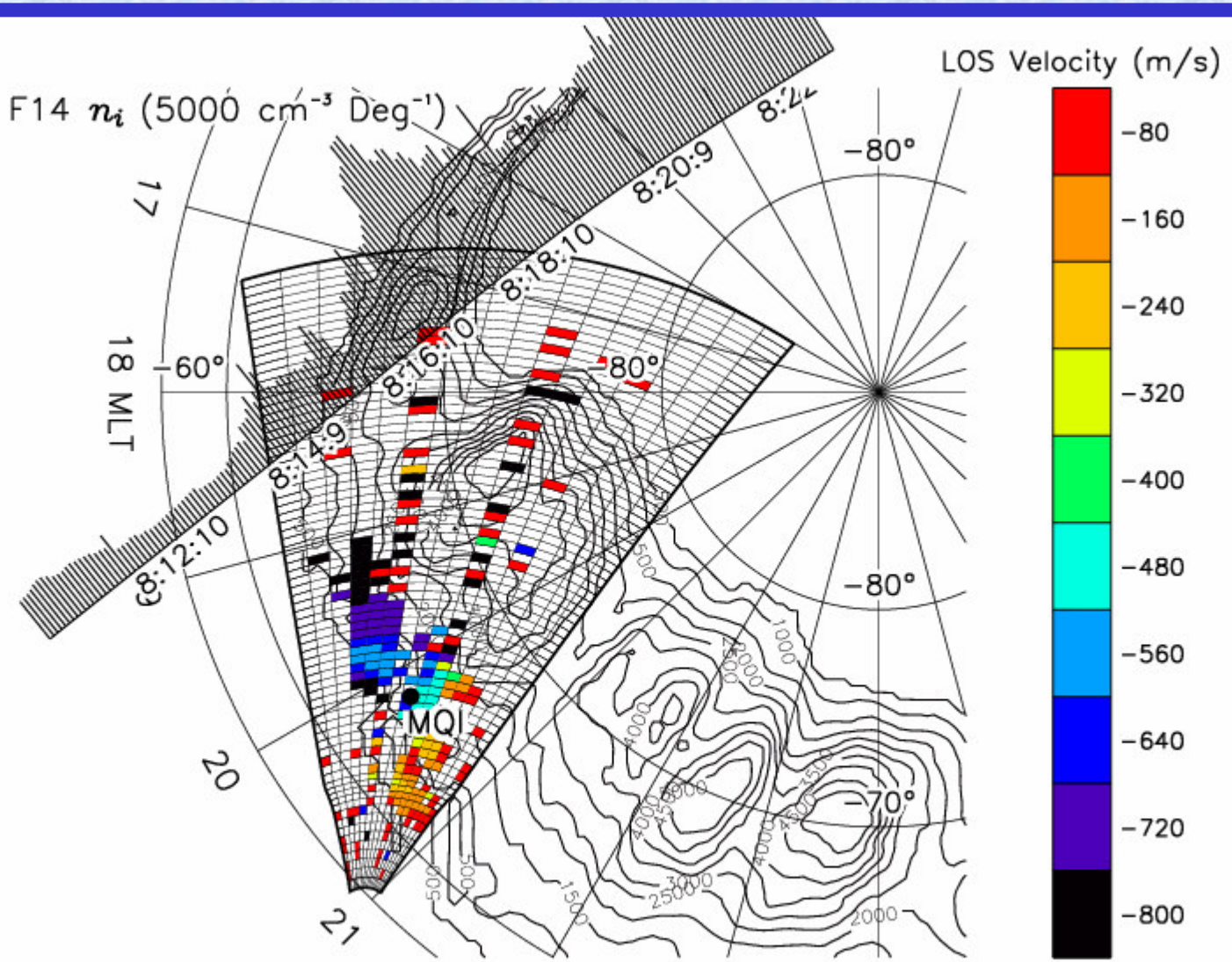
Bottom: ***Macquarie Island (65°Λ) fluxgate magnetometer records: ionospheric Hall current flow.***





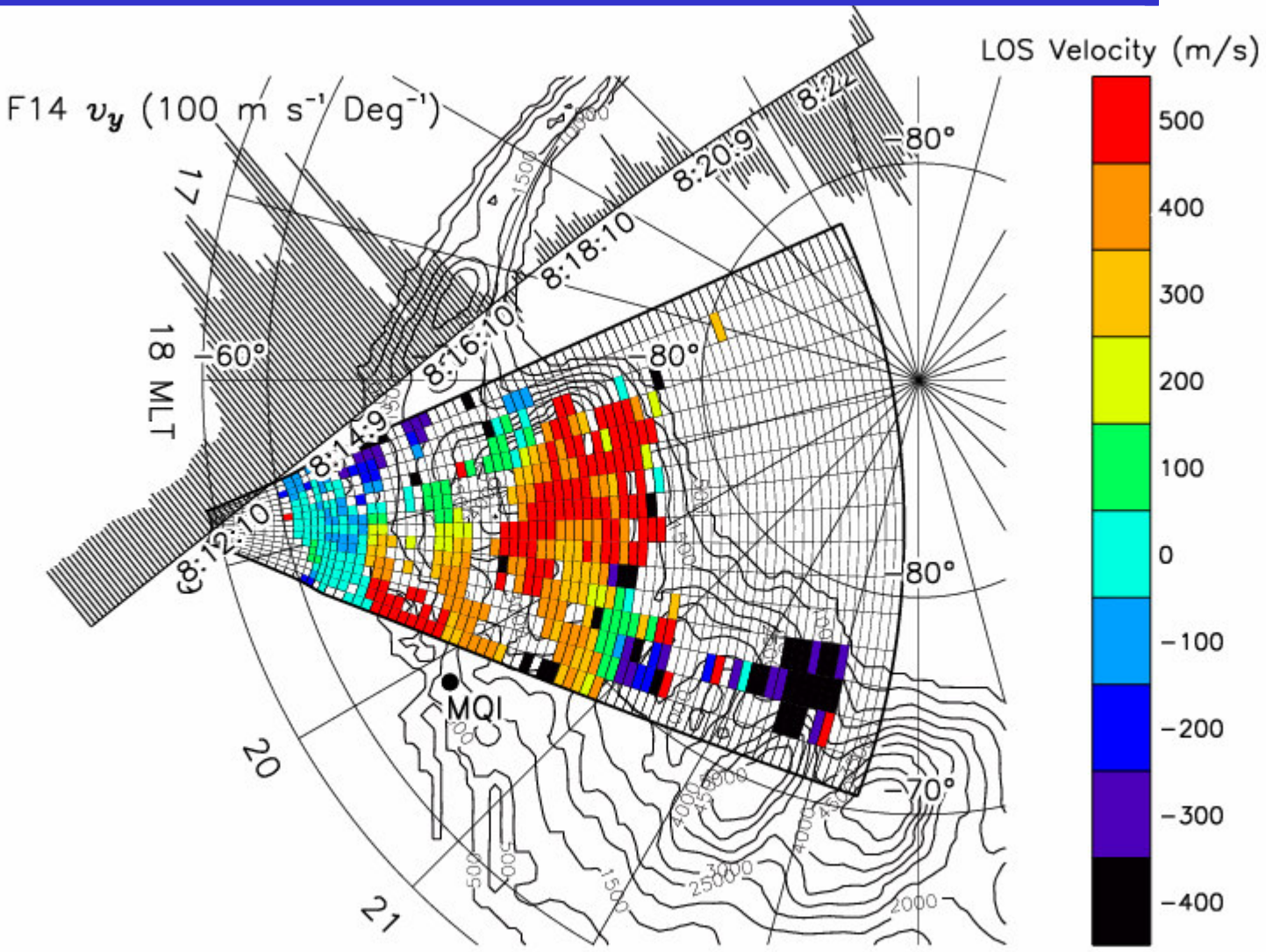


King Salmon full scan, 08:15:59 UT, 30 November 2002



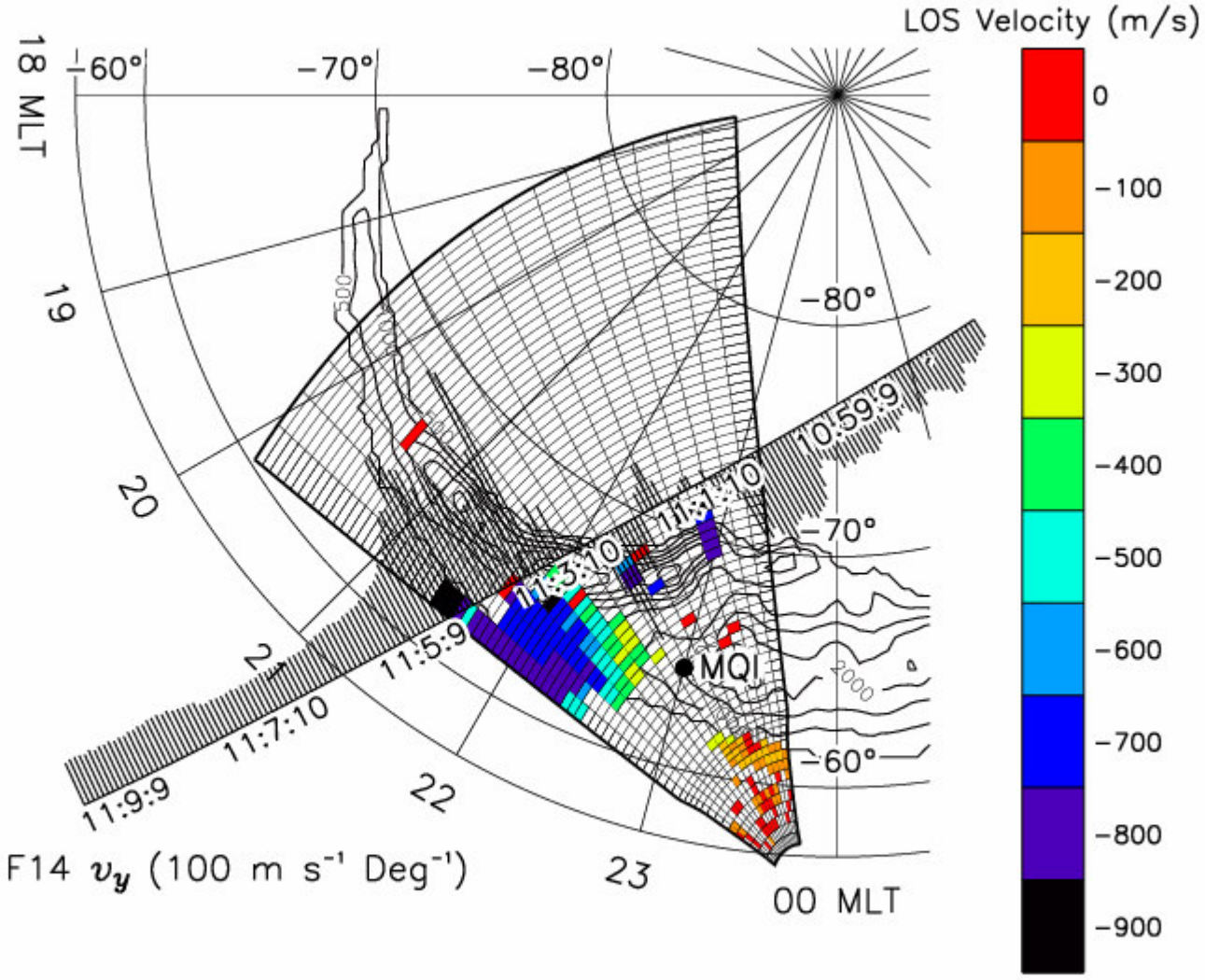
WIC *FUV* Image, 08:15:54 UT

TIGER full scan, 08:15:00 UT, 30 November 2002



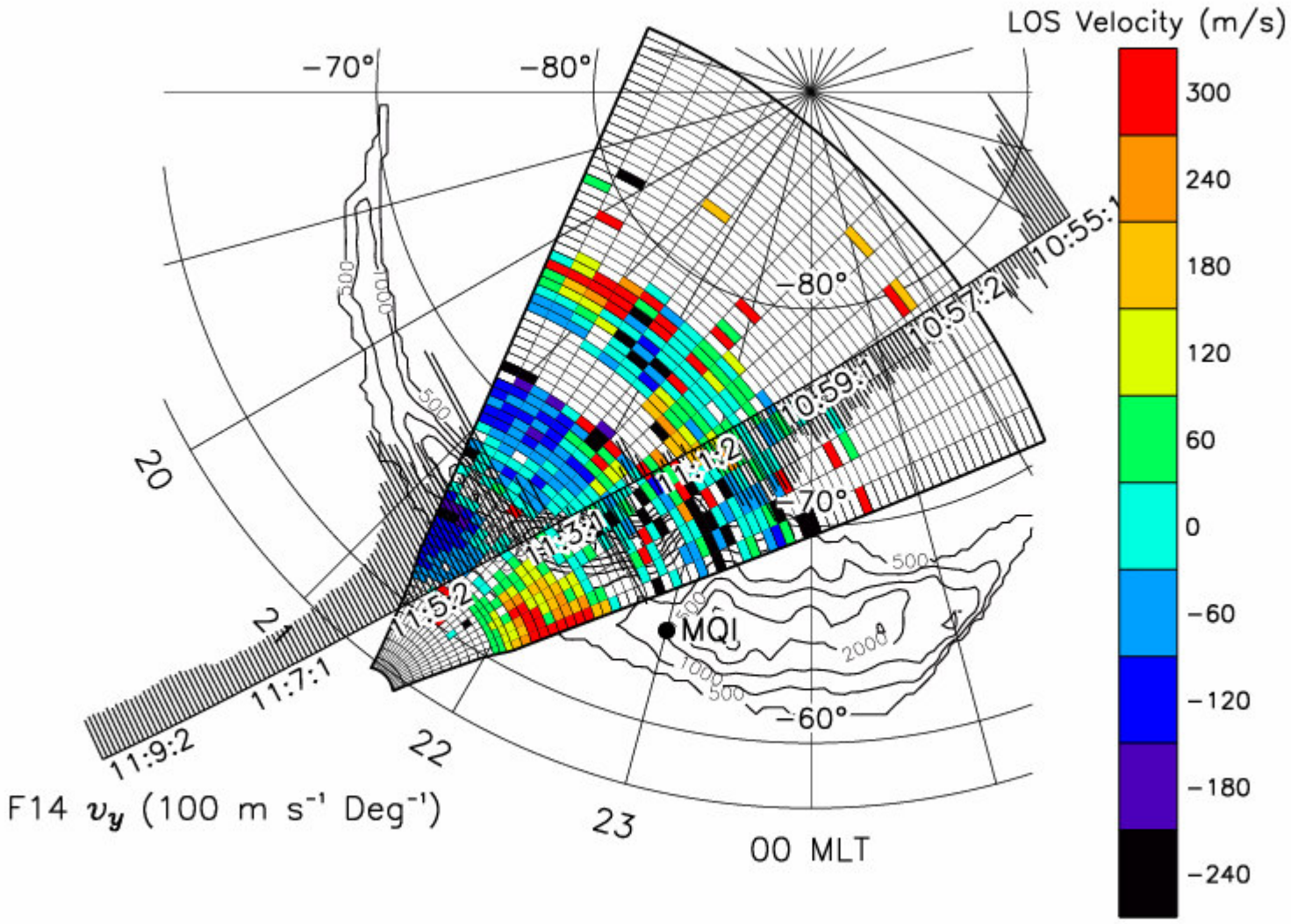
WIC *FUV* Image, 08:15:54 UT

King Salmon full scan, 11:03:59 UT, 30 November 2002



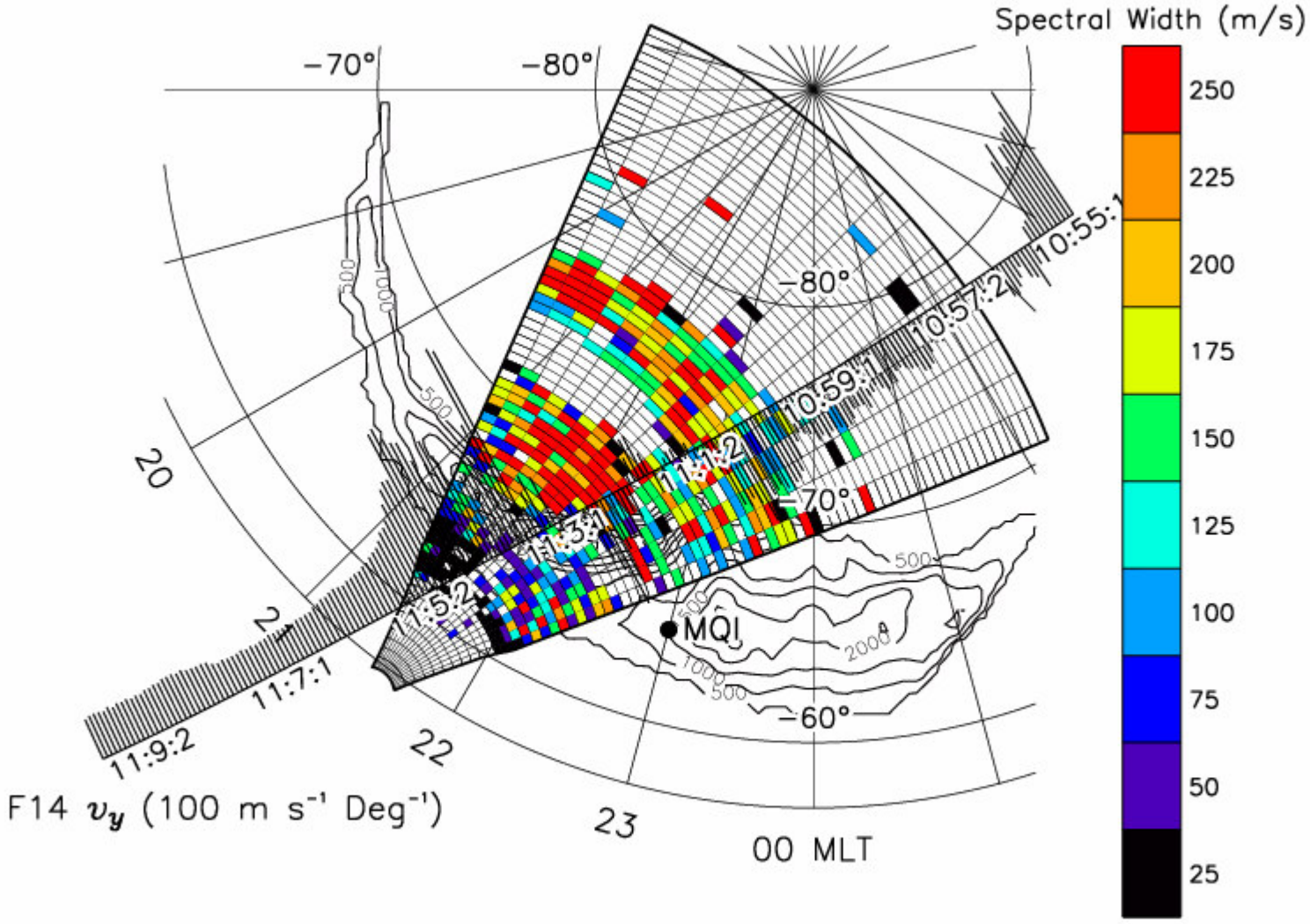
WIC *FUV* Image, 11:04:19 UT

TIGER full scan, 11:03:59 UT, 30 November 2002



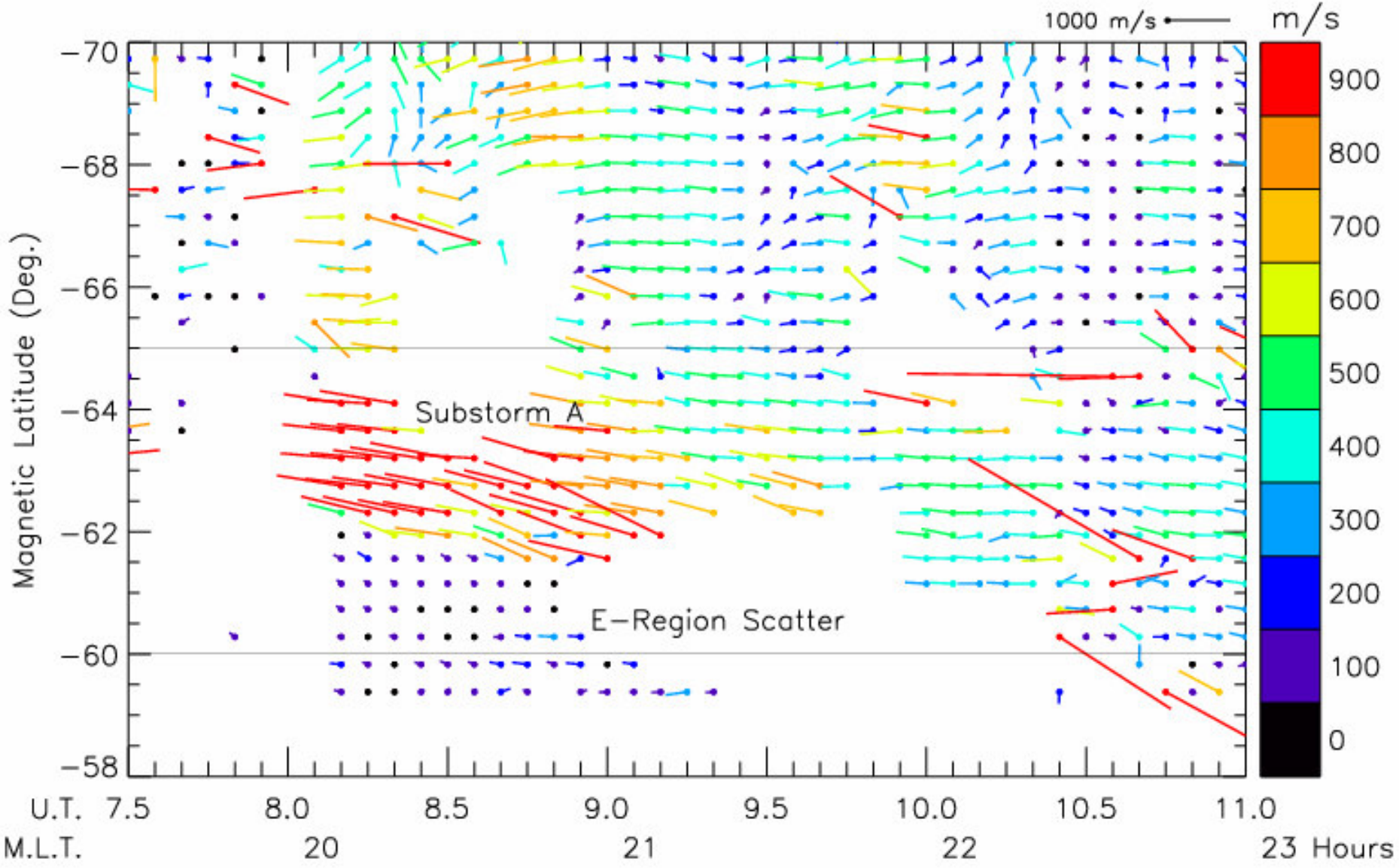
WIC *FUV* Image, 11:04:19 UT

TIGER full scan, 11:03:59 UT, 30 November 2002

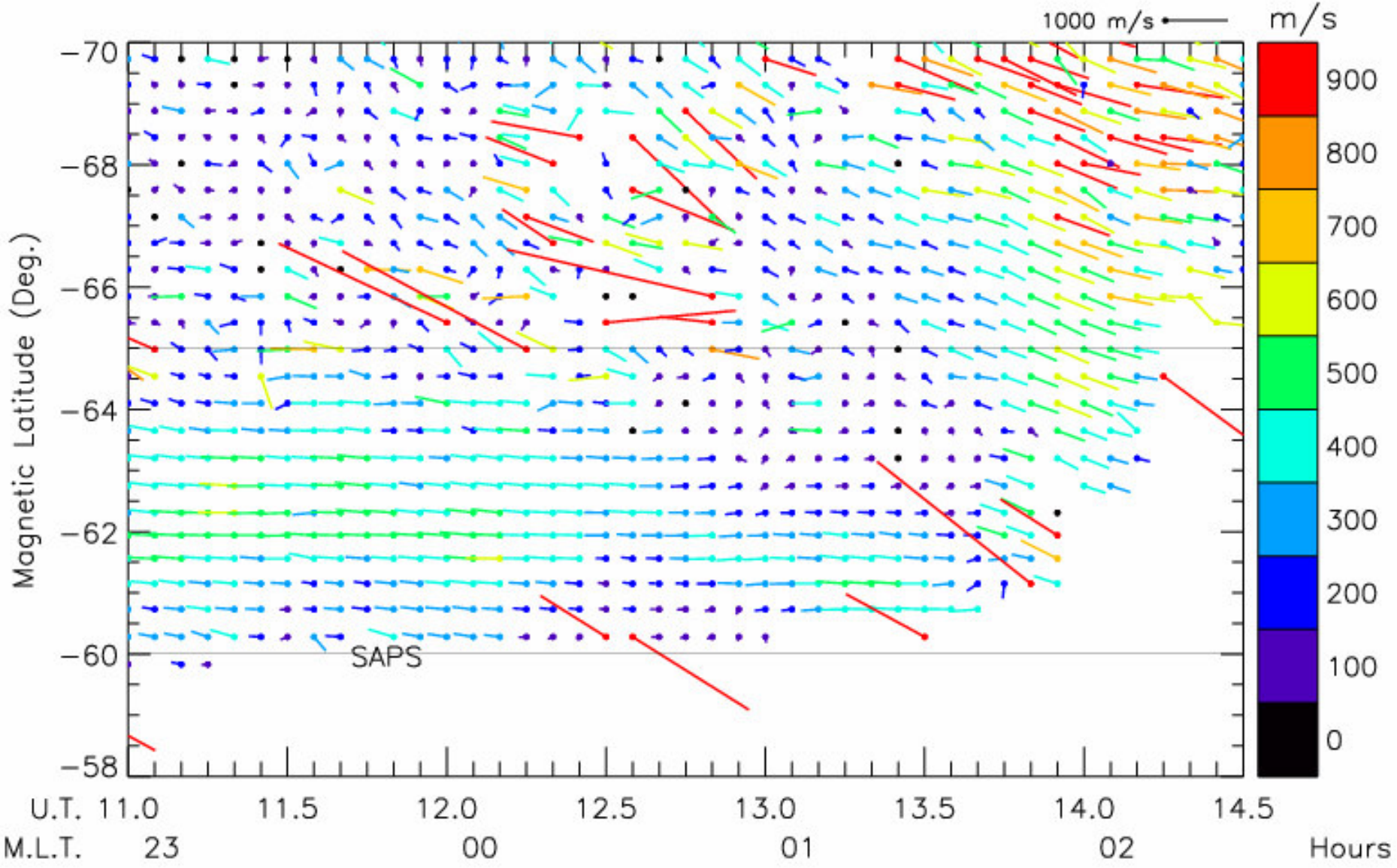


WIC *FUV* Image, 11:04:19 UT

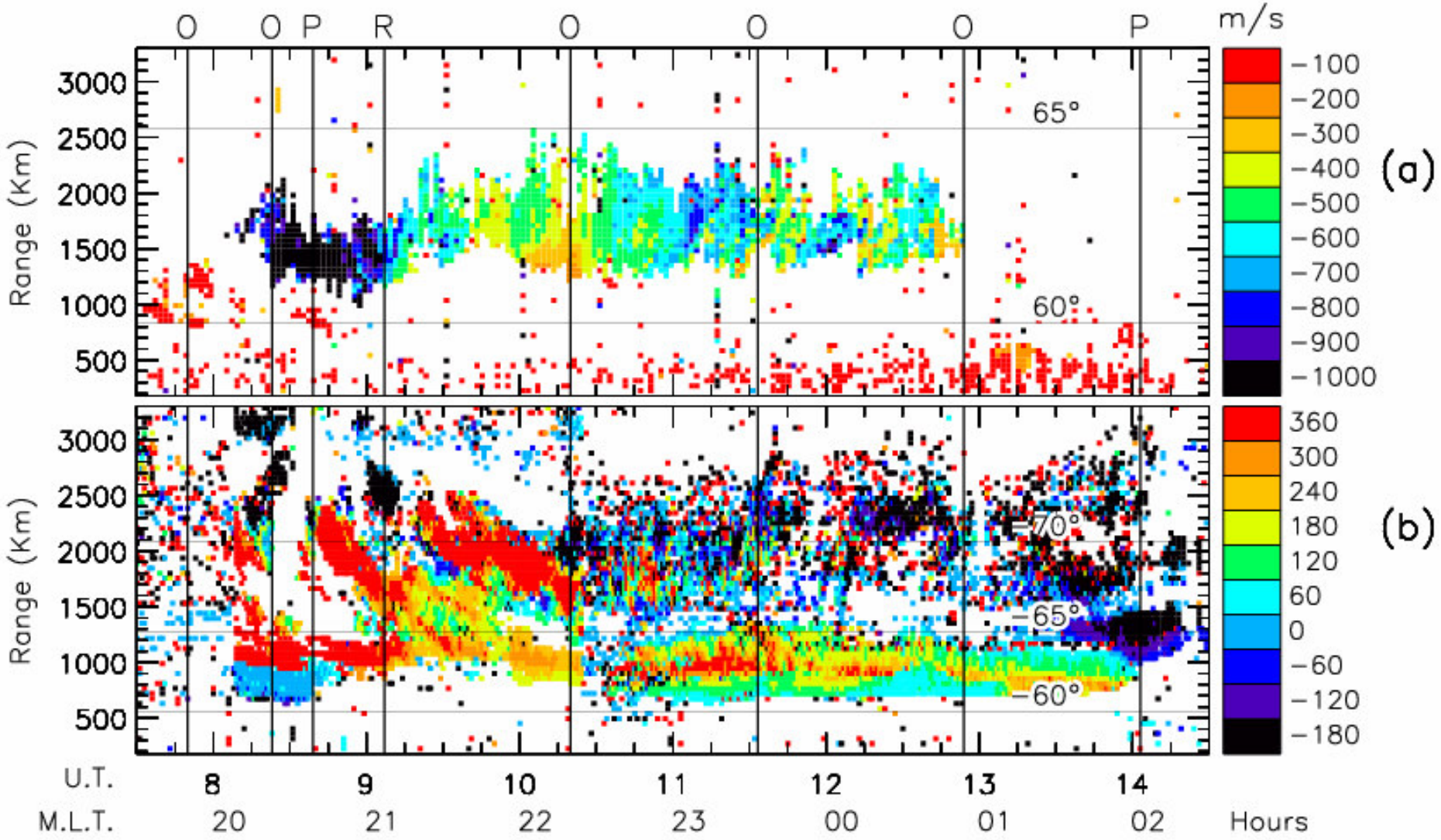
TIGER beam-swinging vectors, 30 November 2002



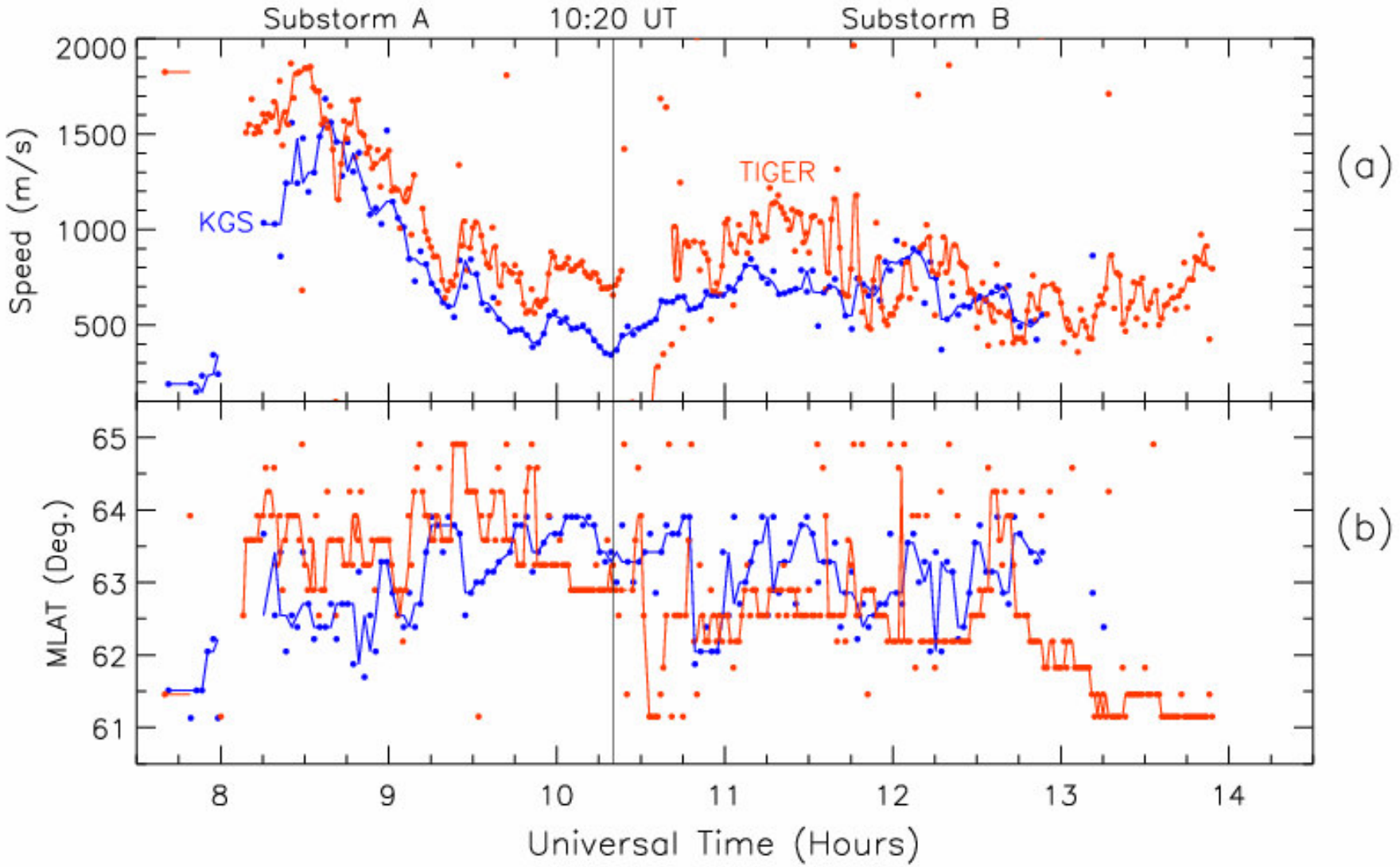
TIGER beam-swinging vectors, 30 November 2002



(a) *King Salmon*, Beam 2, (b) *TIGER* Beam 14



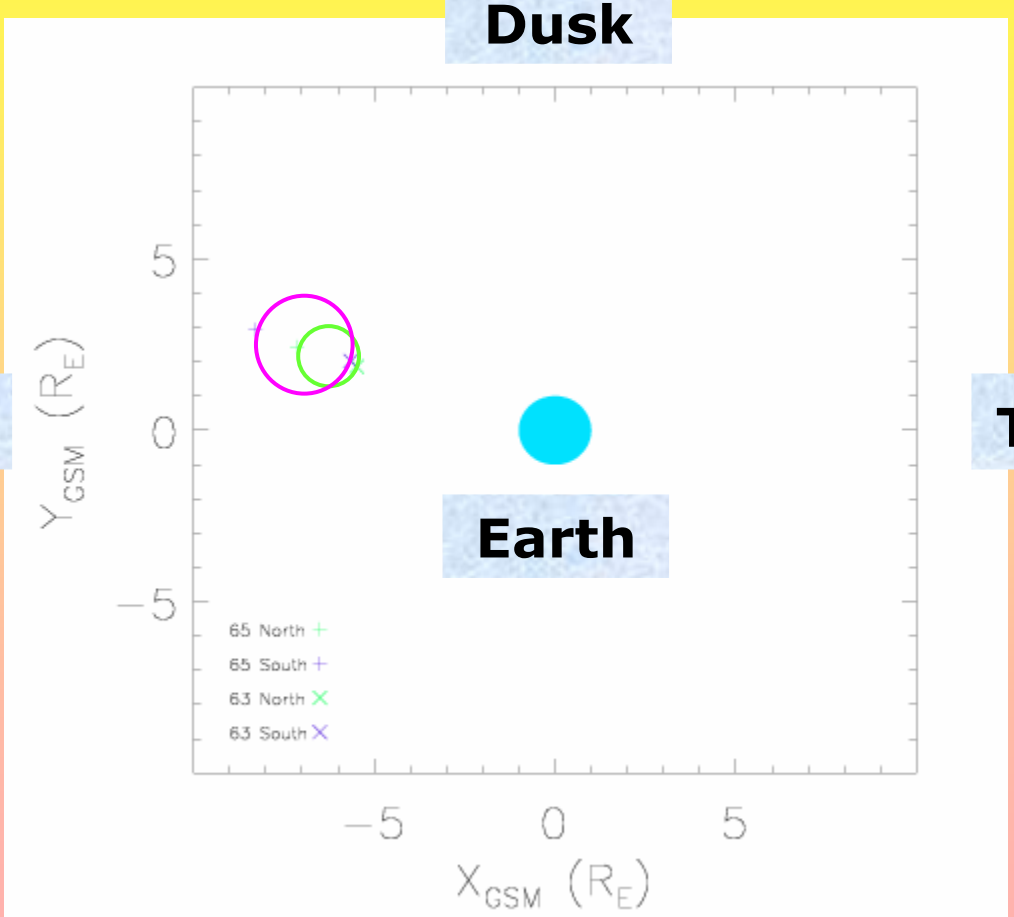
Magnetic conjugacy, *King Salmon* beam 2, *TIGER* beam 14



Tsyganenko 96 field-line tracing, IMF B_y = 10 nT and B_z = –5 nT. Intersection of field lines with X_{GSM}–Y_{GSM} plane

Dusk

←Tail



To Sun→

Earth

Dawn

I. J. Coleman, BAS

Summary

The *AWFC* activity in conjugate hemispheres was consistent with the magnetic flux tubes being equi-potentials at larger spatial and temporal scales. Differences in the characteristics of the conjugate *AWFC* activity can be accounted for by:

- **Asymmetries in HF propagation conditions and plasma density gradients leading to irregularity production. i.e., each radar observed different facets of the *AWFC* activity.**
- **Inaccuracies in the inference of flow speed and direction using isolated radars without dual overlapping fields of view.**
- **Inaccuracies in the magnetic field-line mapping of the observed scatter.**

Detailed knowledge of the actual magnetospheric currents in 4D (i.e. in space and time) would be required to solve the last problem.

Even so, the radar data suggests the conjugate magnetic flux tubes were not equi-potentials at smaller spatial and temporal scales, probably because of different variations in the Pedersen conductance in the Northern and Southern Hemispheres, and thus different field-aligned potential drops in proximity to the auroral oval.