Stormtime Ion Redistribution at Mid-Latitudes: A Coupled Geospace Phenomenon

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NSF CEDAR
NASA Living With A Star TR+T Program
Google Earth Imagery
The Space Physics Community

* NSF REU undergraduate

Mesoscale Ionospheric Redistributions

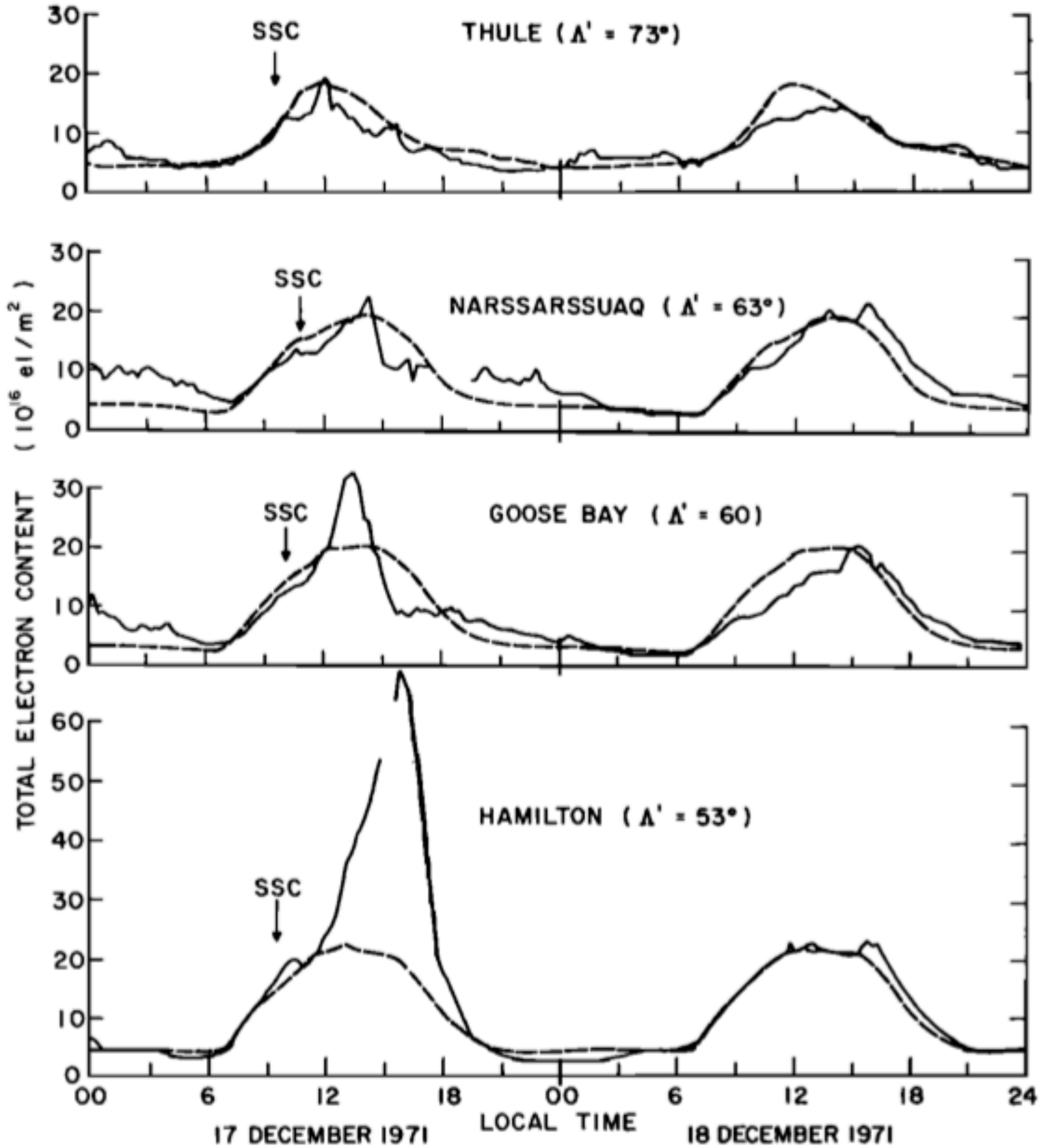


Fig. 5. TEC data from AFRCL facilities at Thule, Narssarssuaq, Goose Bay, and Hamilton for December 17–18, 1971. The dashed curves give the monthly median behavior at each station, and the small arrows mark the local times of the ssc at 1418 UT.

AFCRL network observing ATS series geosynchronous VHF beacons

Differential Doppler estimate of TEC

17 December 1971

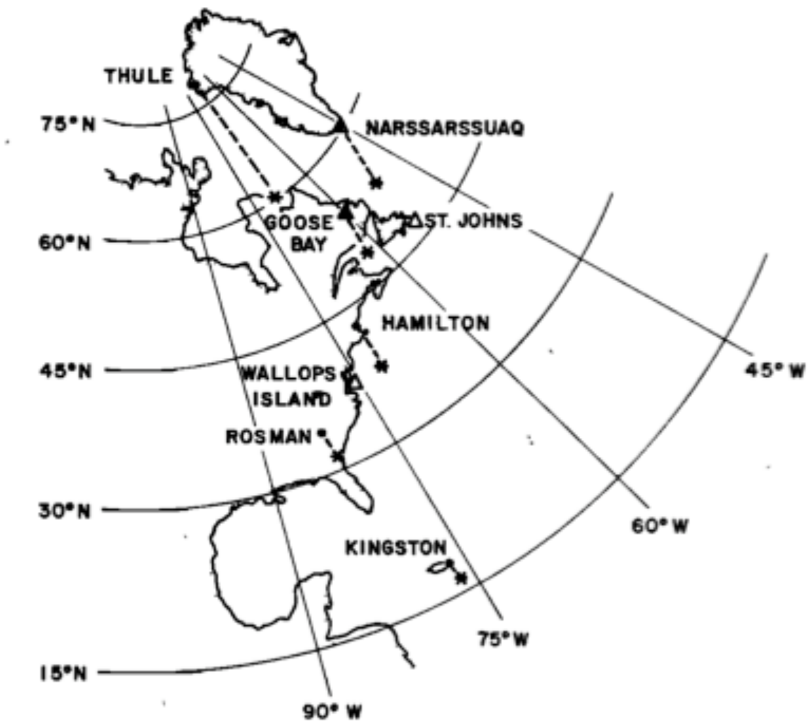
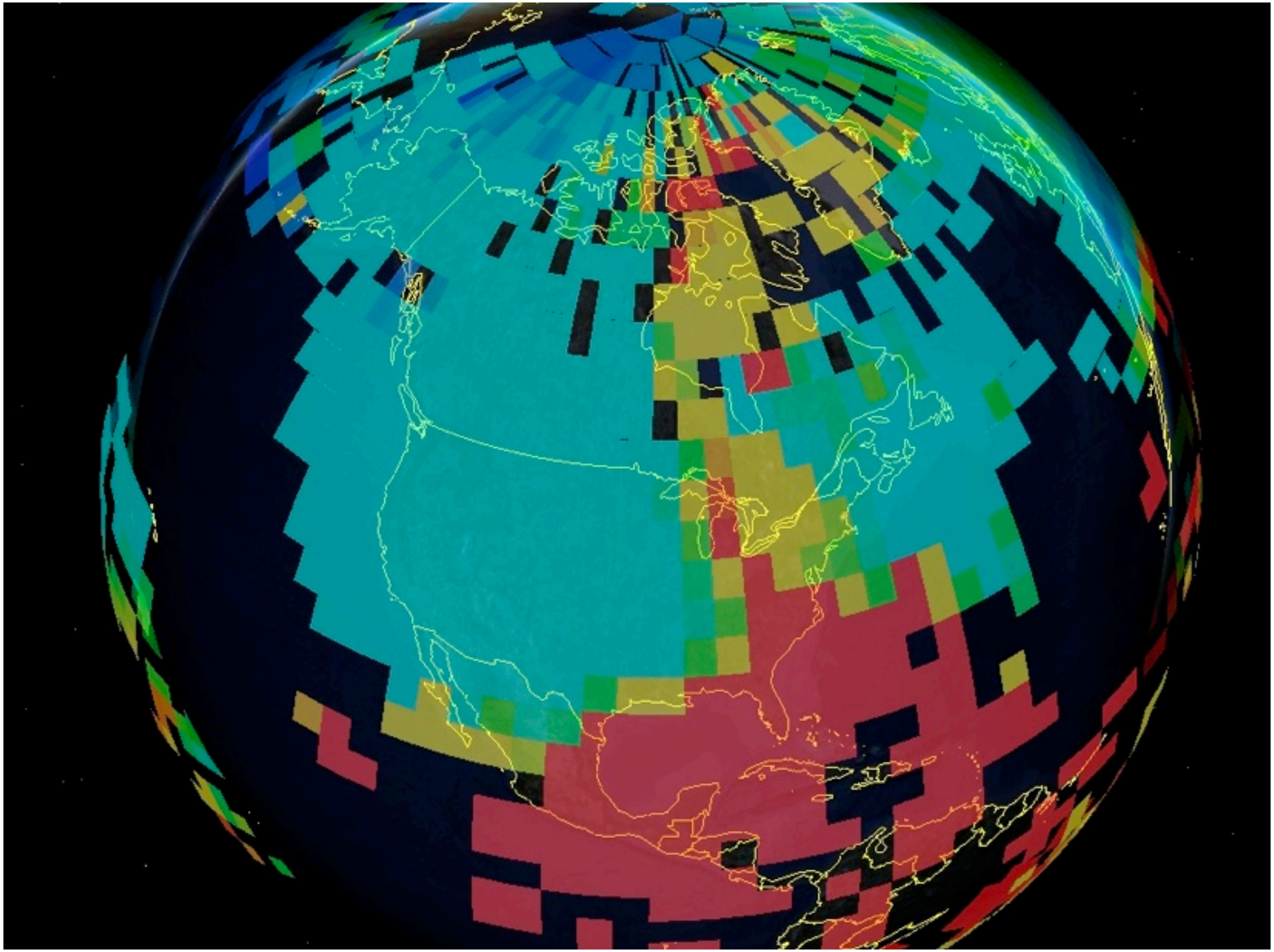


Fig. 1. Locations of TEC observing stations (solid dots), their 420-km subionospheric points (asterisks) for ATS 3 at 70°W, and the near-by ionosonde stations (open triangles).

Mendillo and Klobuchar, 1975

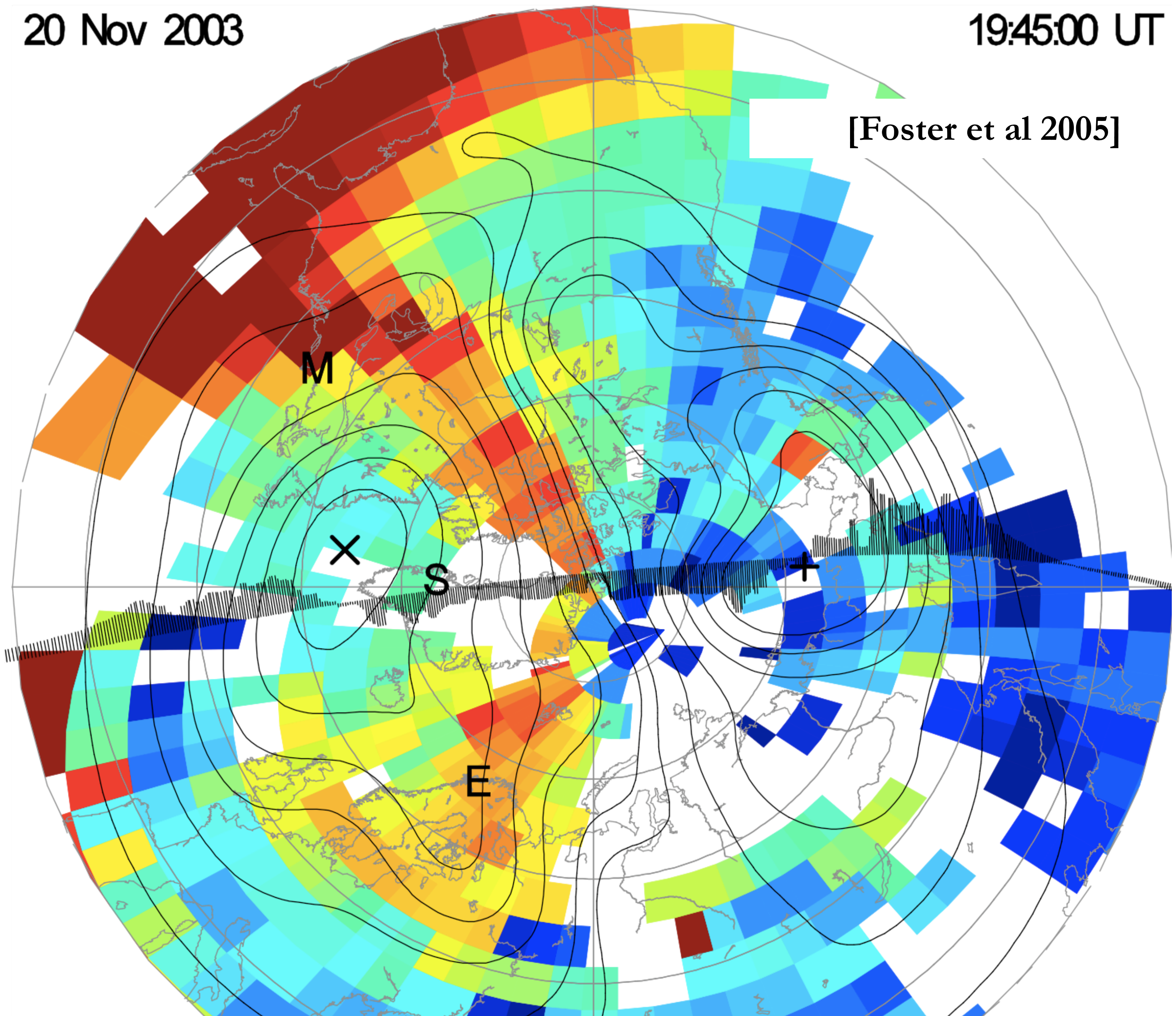
Mesoscale Ionospheric Redistributions



GPS TEC
[0, 60] TECu

Nov 20, 2003
1840 - 1900 UTC

System-Level Redistribution Paths

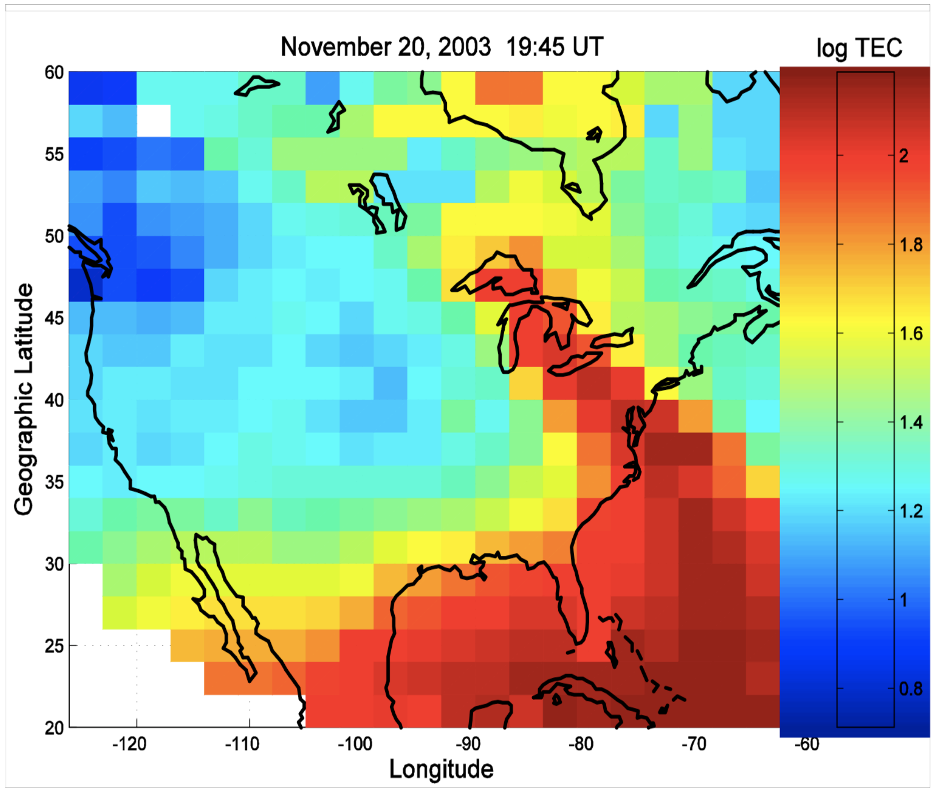


Merged SuperDARN/DMSP Convection
Common projection: maglat/MLT @ 350 km alt

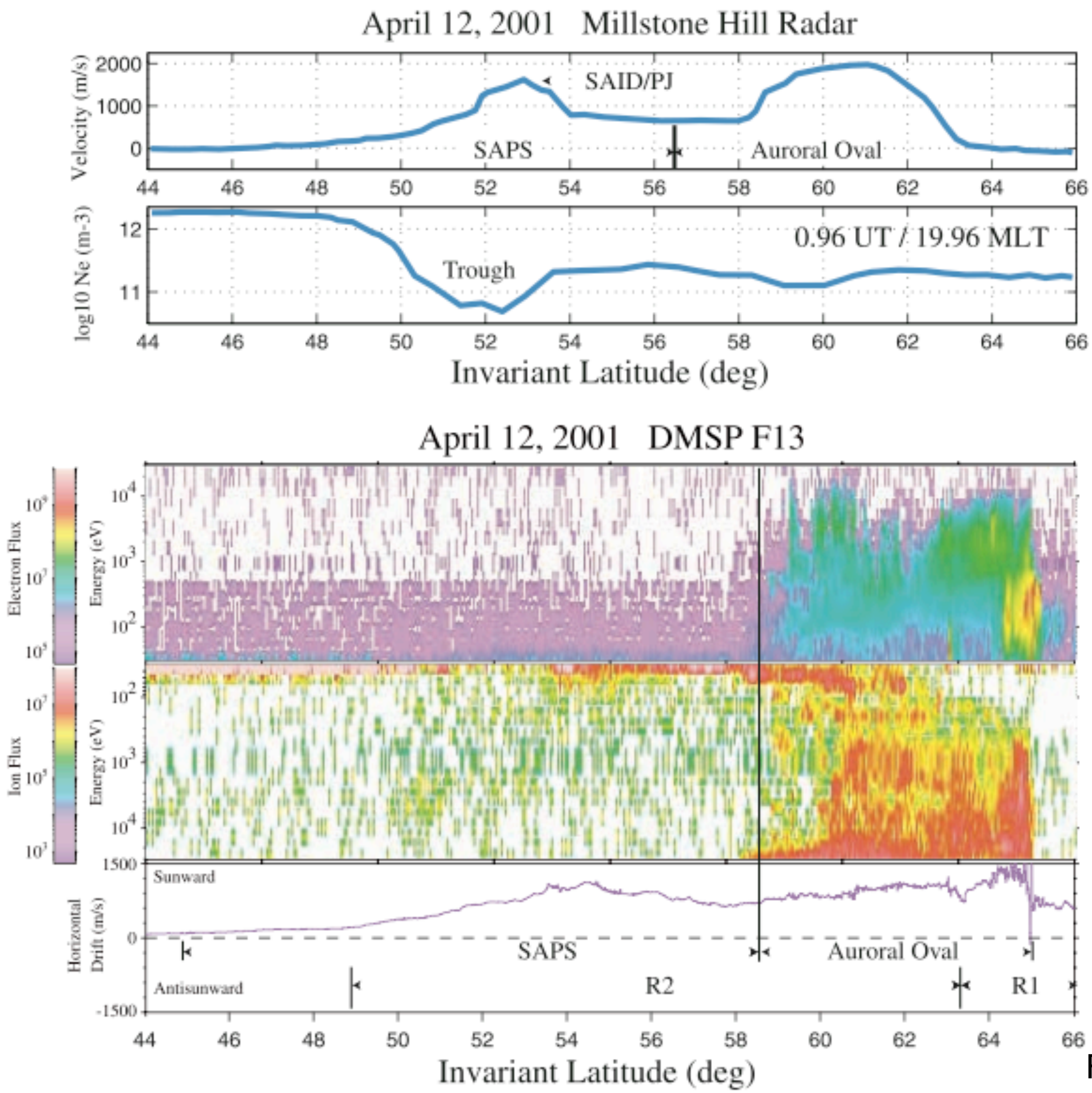
Active plasma redistribution couples equatorial and polar latitudes through mid-latitudes

SED, polar tongue of ionization created through actions of region 2 linked SAPS electric fields (M-I coupling)

GPS TEC Map



Sub-Auroral Polarization Stream (SAPS)



Westward (sunward) subauroral velocity near footprint of region 2 / ring current

2-5 deg wide

Embedded small and highly variable structures (SAID)

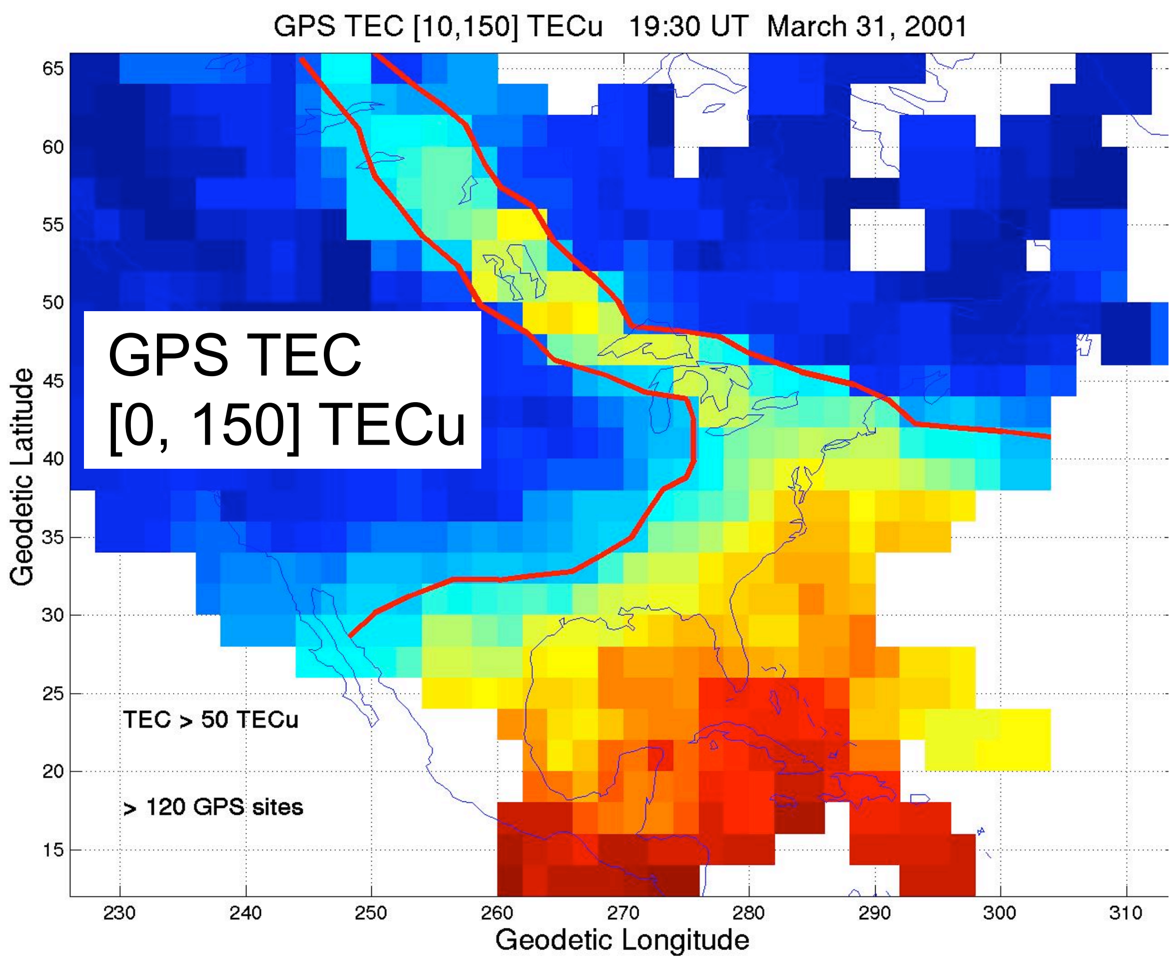
Overlaps edge of storm enhanced density (SED)

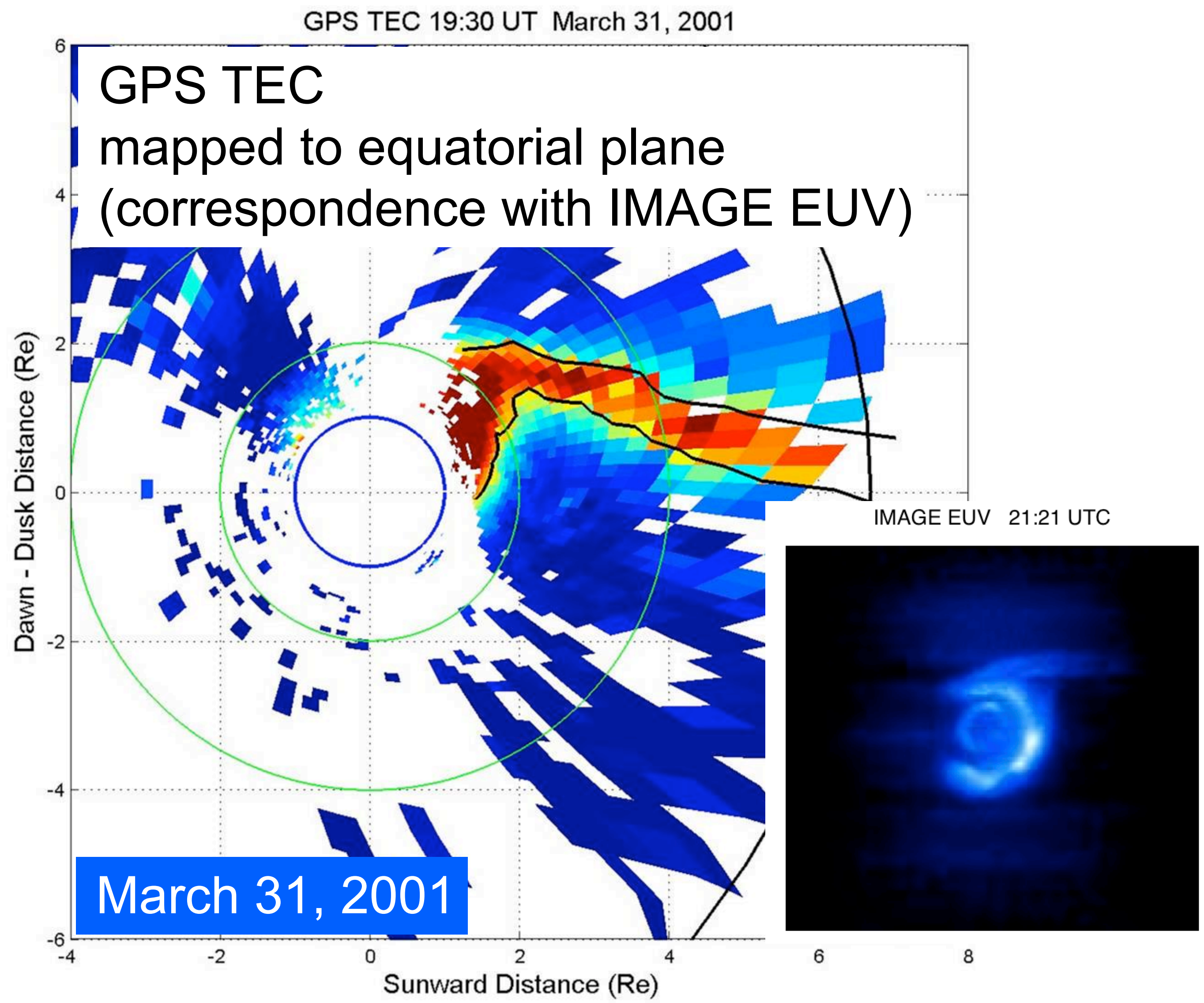
Dusk sector transport of material to noontime cusp

Foster and Vo, 2002

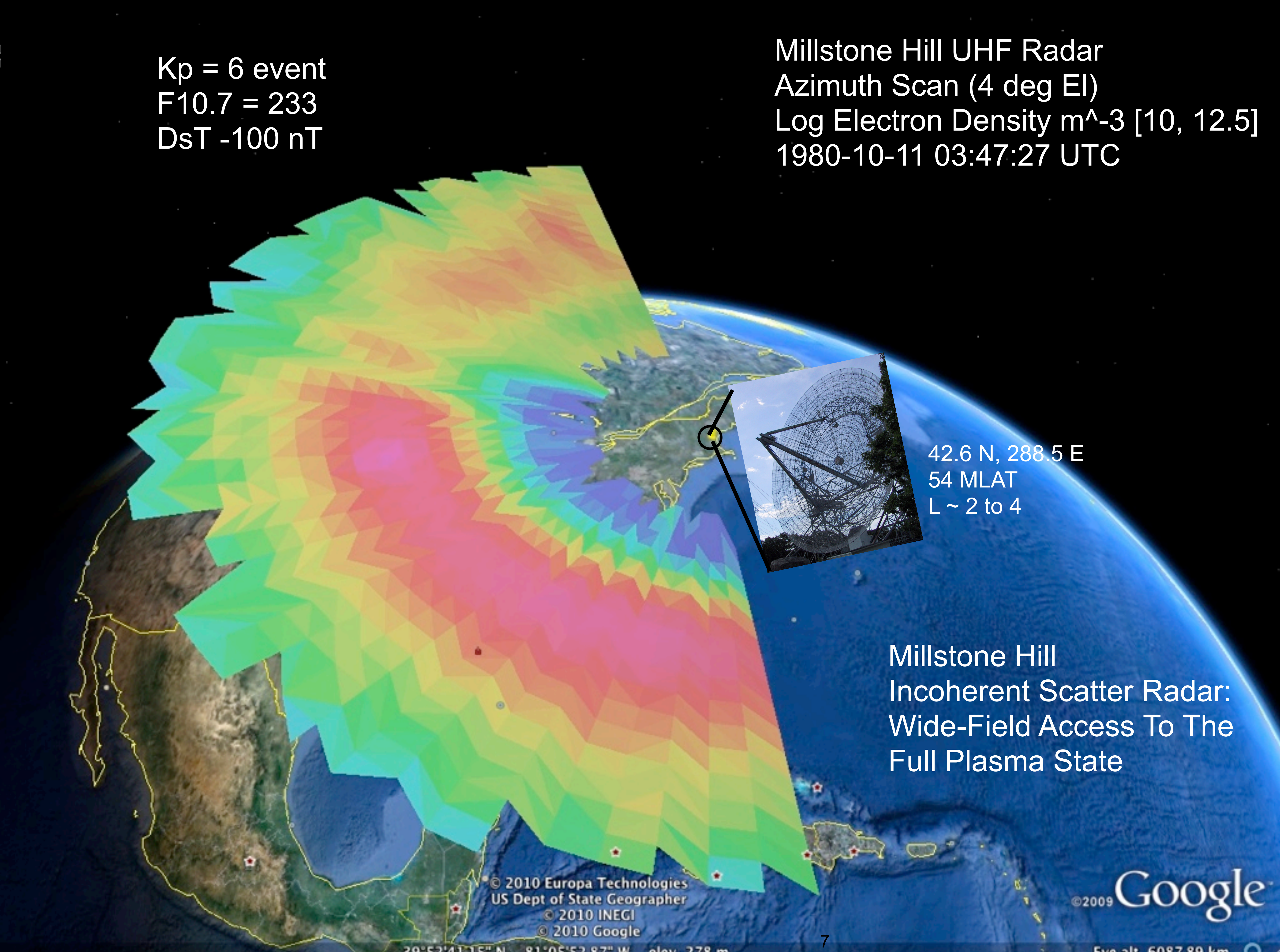
The Coupled Geospace Observational View

What are the *statistical and system* characteristics of this mesoscale redistribution in the ionosphere?





(e.g. Foster et al 2004)


Kp = 6 event
F10.7 = 233
DsT -100 nT
Millstone Hill UHF Radar
Azimuth Scan (4 deg El)
Log Electron Density m^-3 [10, 12.5]
1980-10-11 03:47:27 UTC
42.6 N, 288.5 E
54 MLAT
L ~ 2 to 4
Millstone Hill
Incoherent Scatter Radar:
Wide-Field Access To The
Full Plasma State
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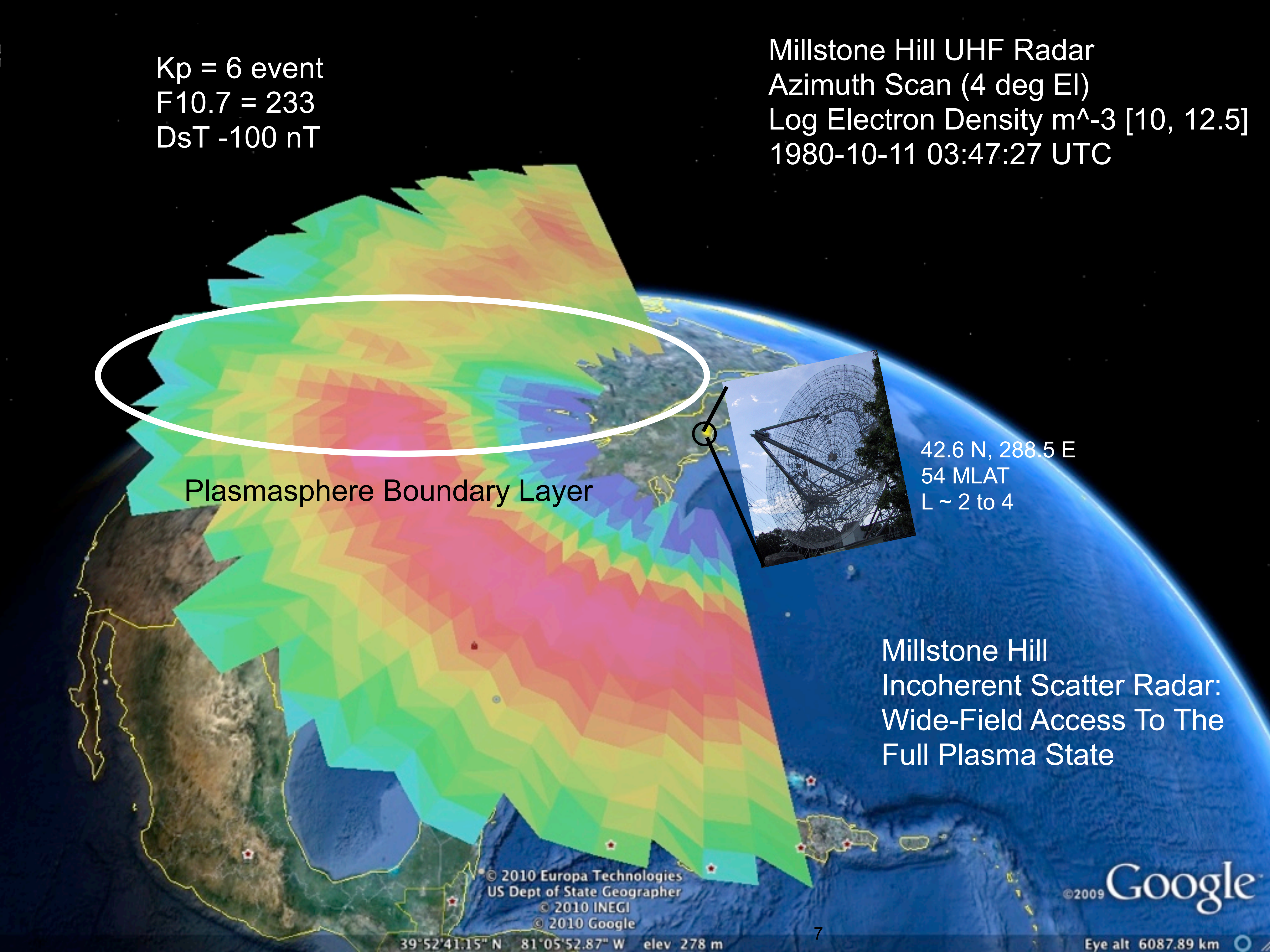
©2009 Google
39°52'41.15" N 81°05'52.87" W elev 278 m
Eye alt 6087.89 km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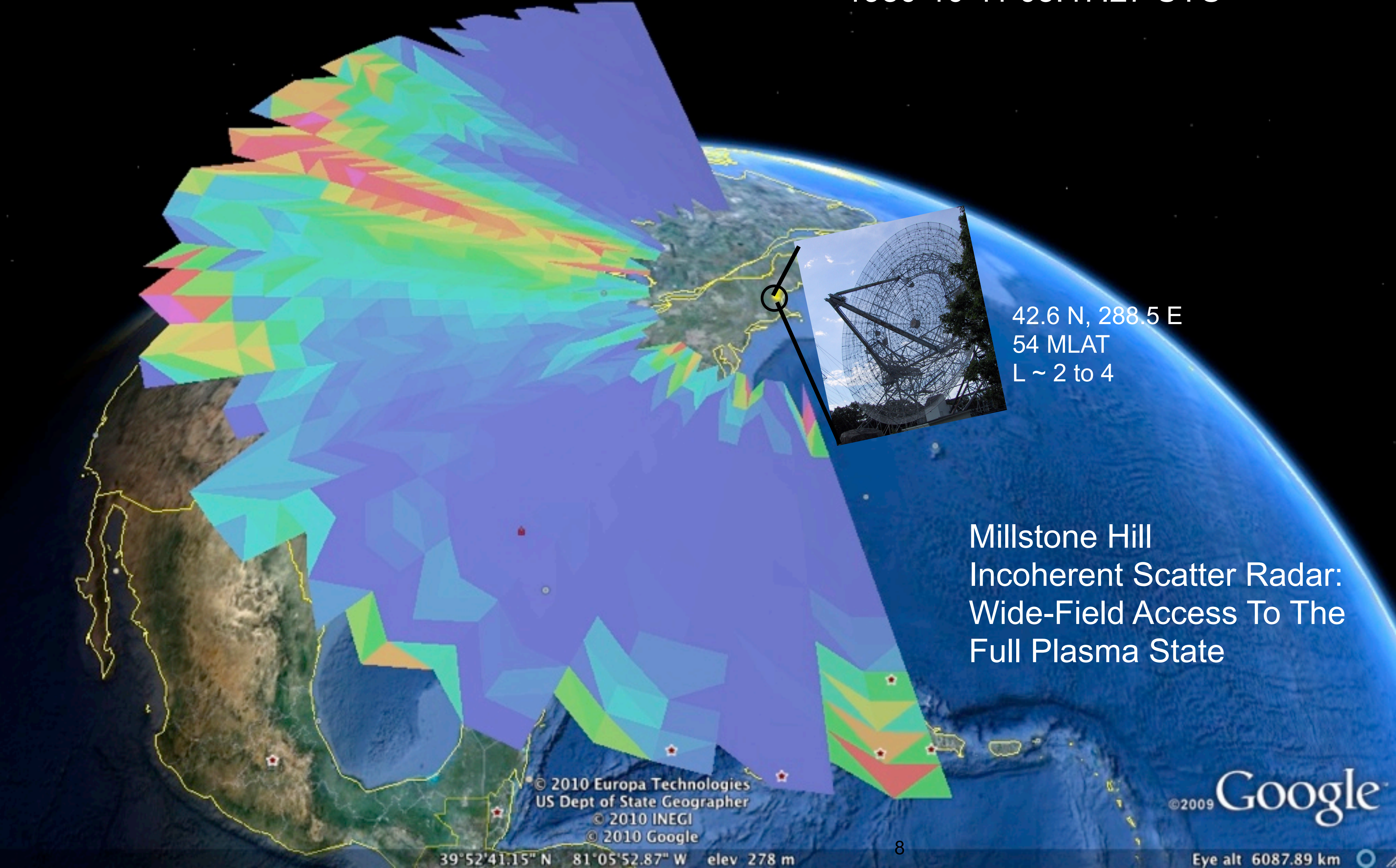
DsT -100 nT

Millstone Hill UHF Radar
Azimuth Scan (4 deg El)
Line-of-sight Ion Velocity [0,800] m/s
1980-10-11 03:47:27 UTC



Millstone Hill
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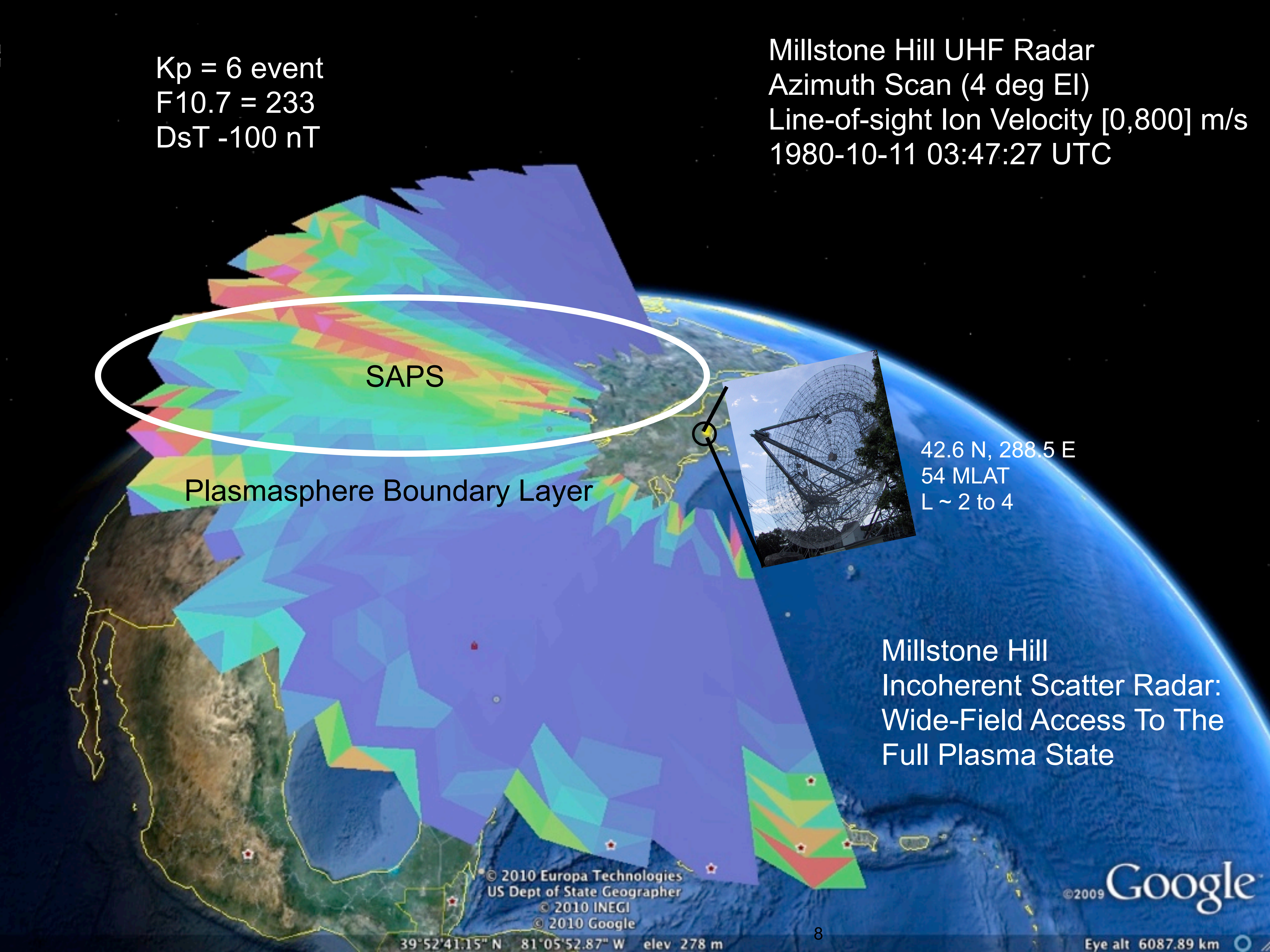

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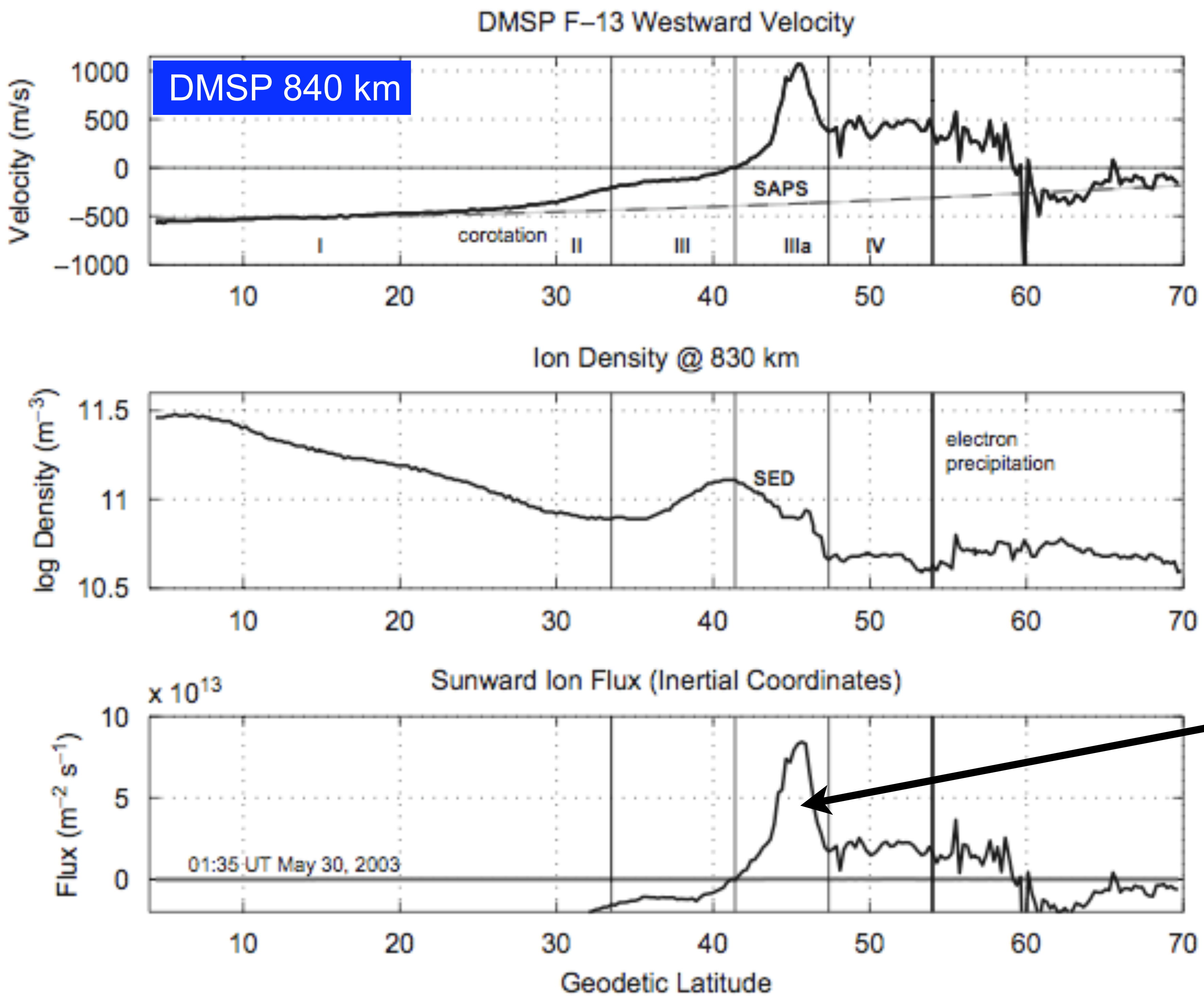
Sunward ion flux driven by SAPS

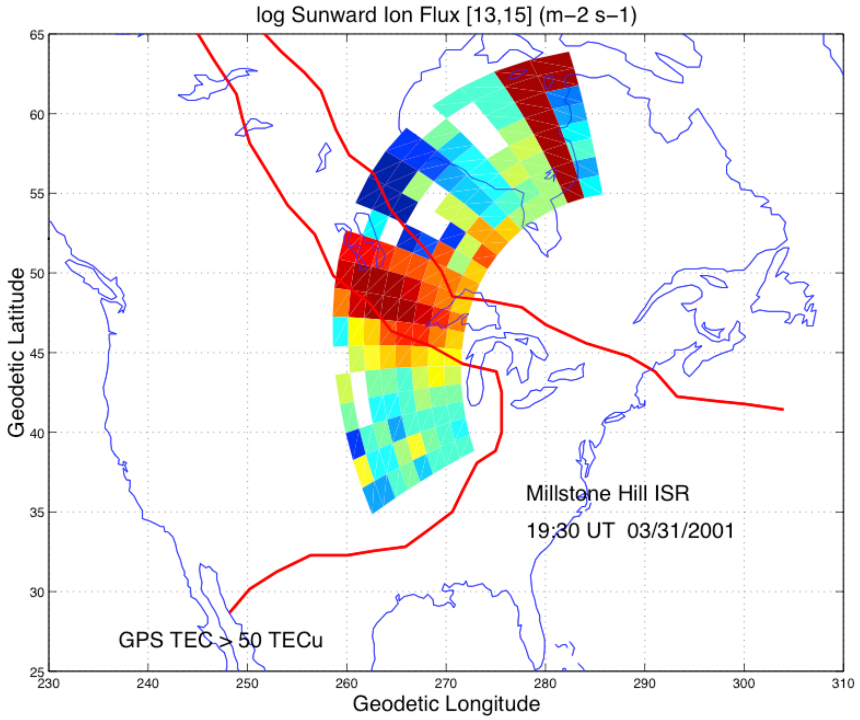


Sunward ion flux caused by SAPS/SED overlap

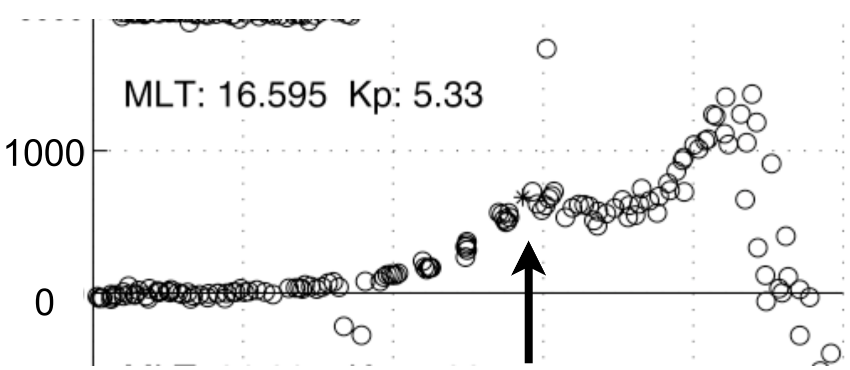
Foster et al, 2007

Mid-Latitude Flows: SAPS Statistical Study

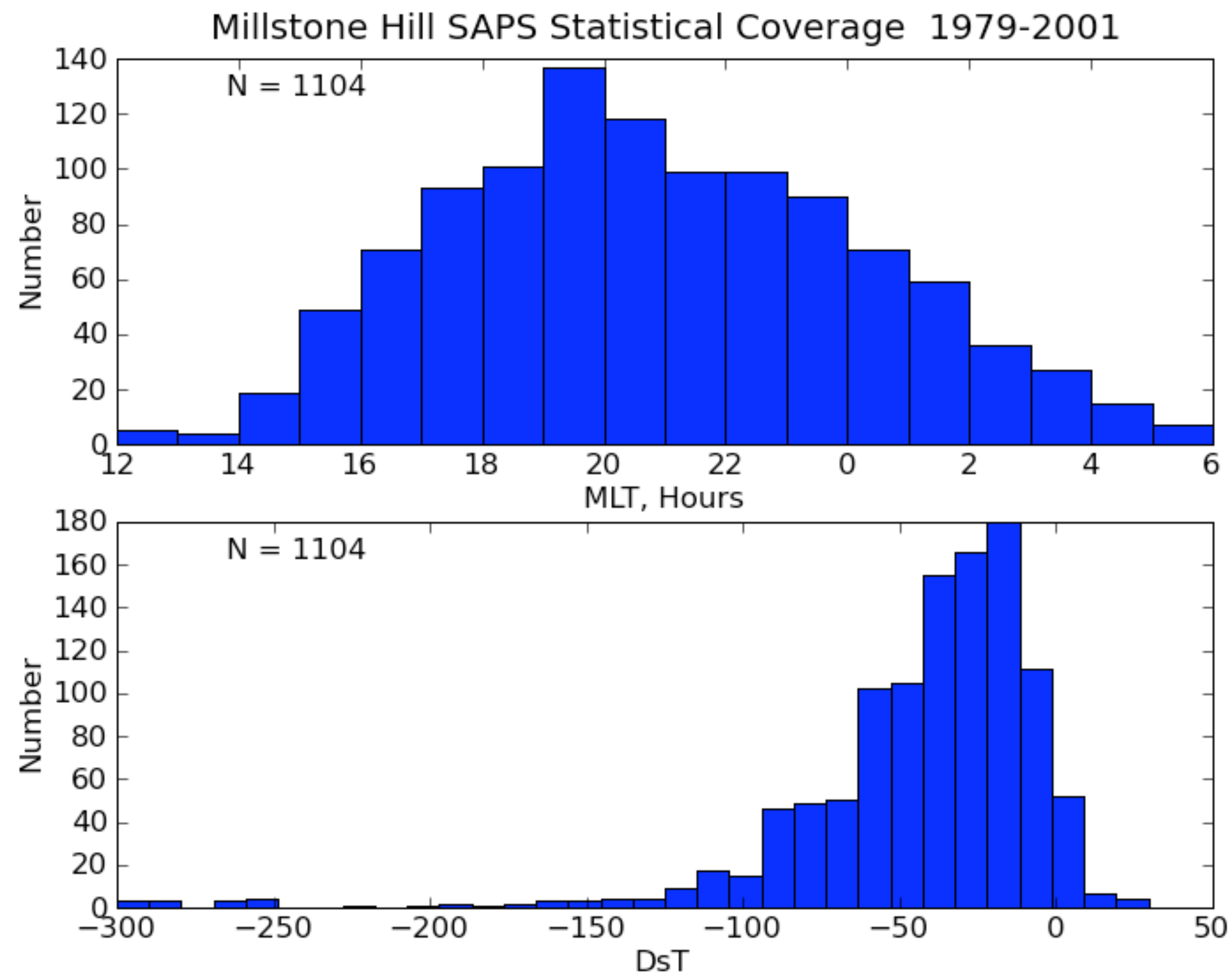
Individual events



Sunward ion velocity, m/s

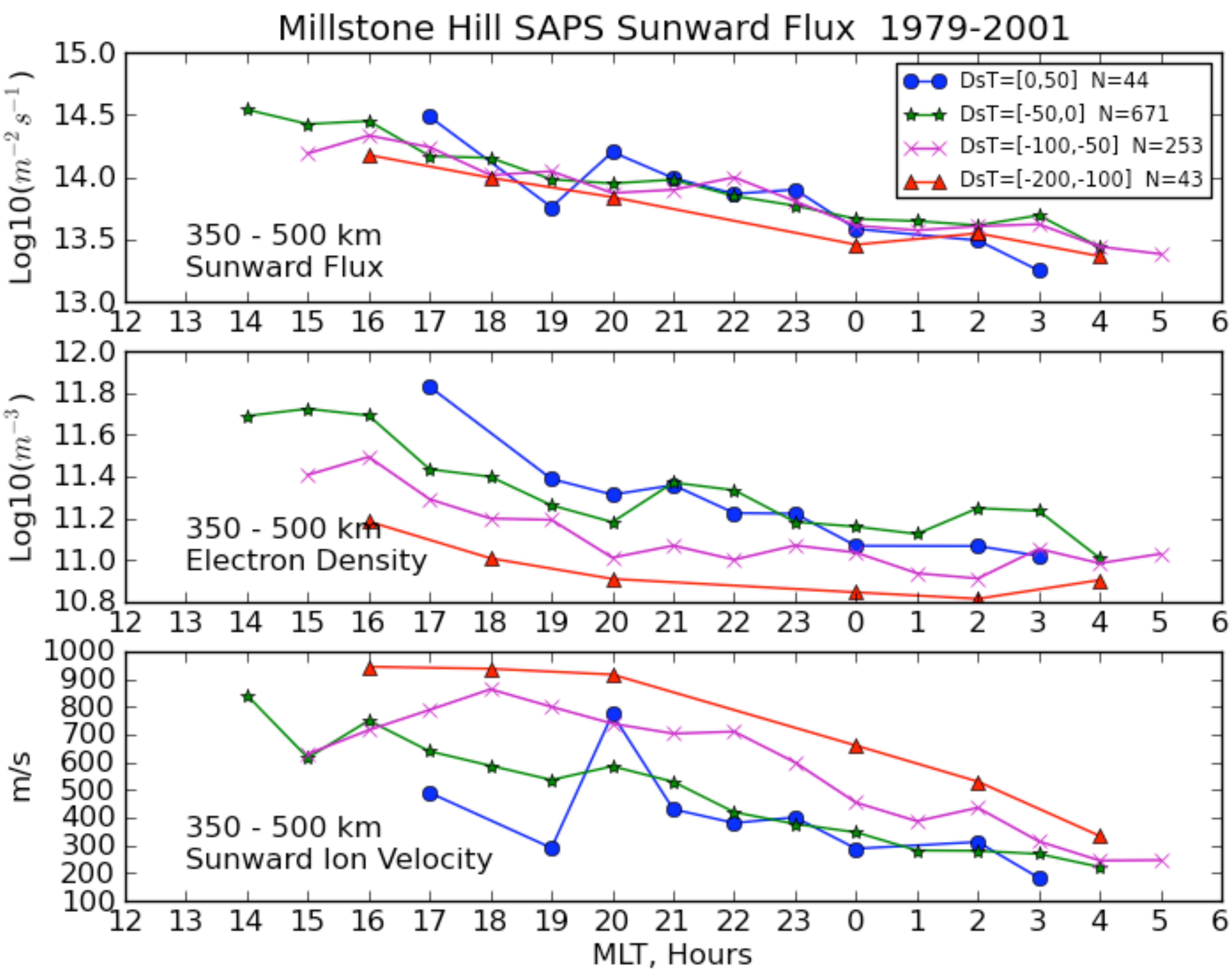


Latitude



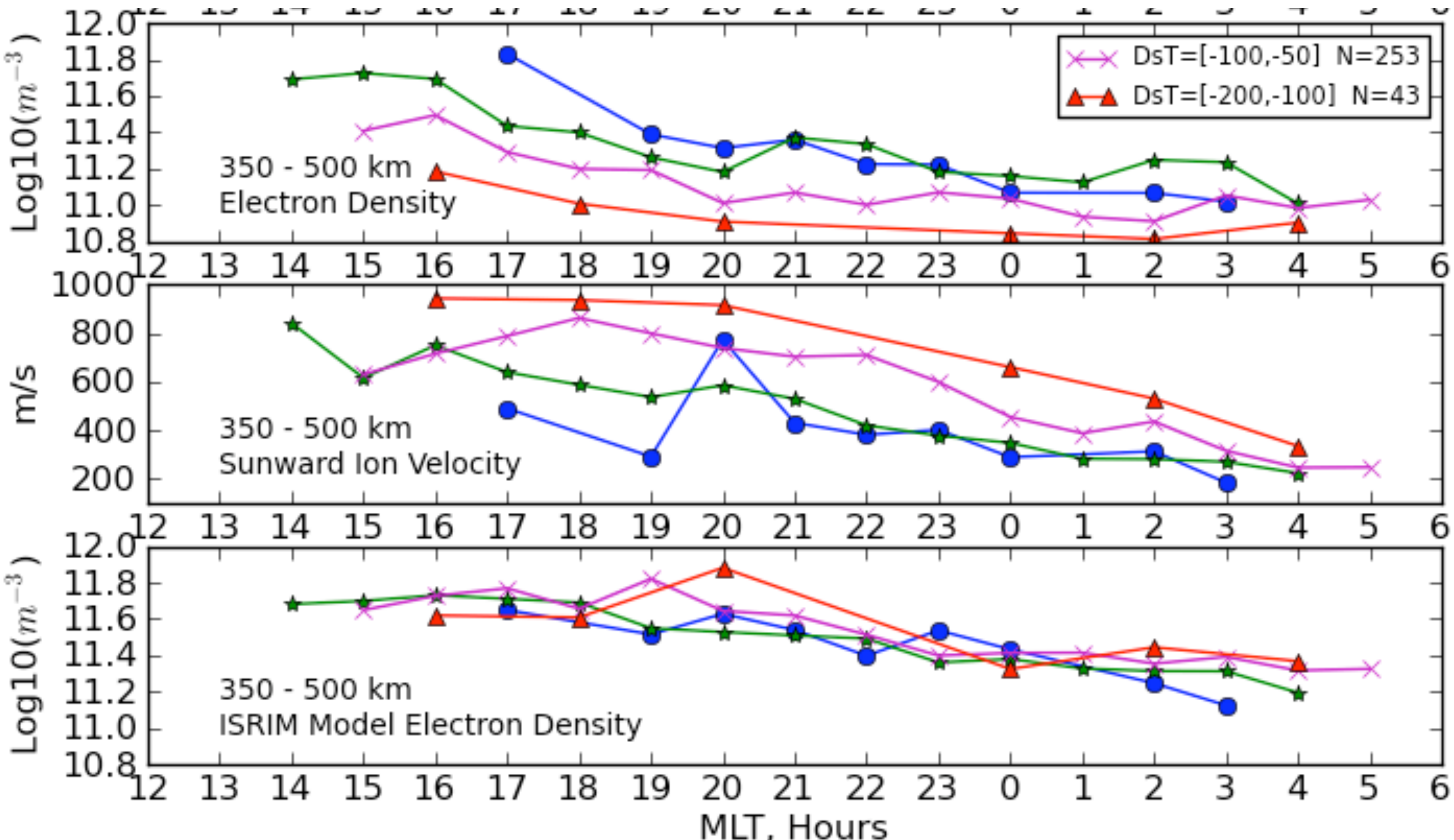
Kp = 2 and greater
10,000+ scan database

SAPS Flux: Inverse Density/Velocity Relation

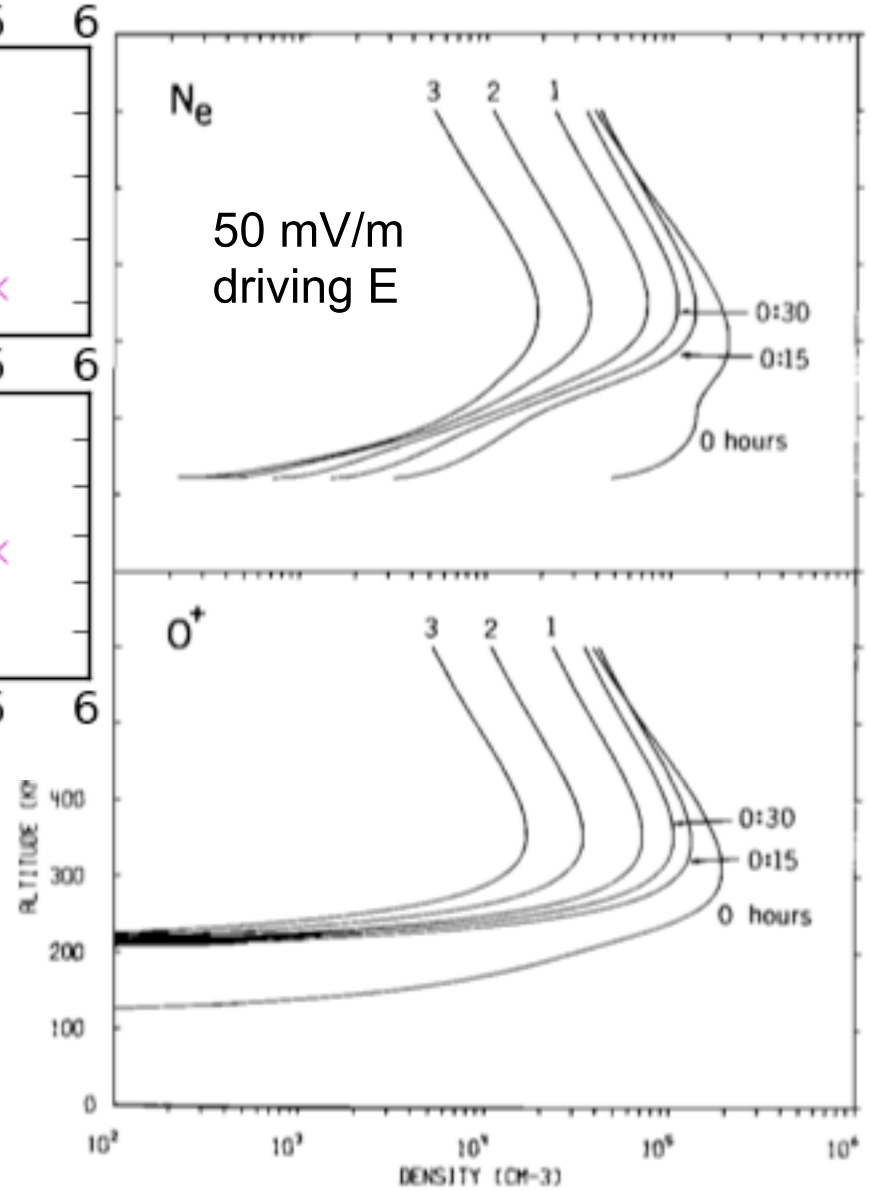


Erickson et al
submitted JGR 2010

SAPS Flux: Inverse Density/Velocity Relation



Schunk et al 1976



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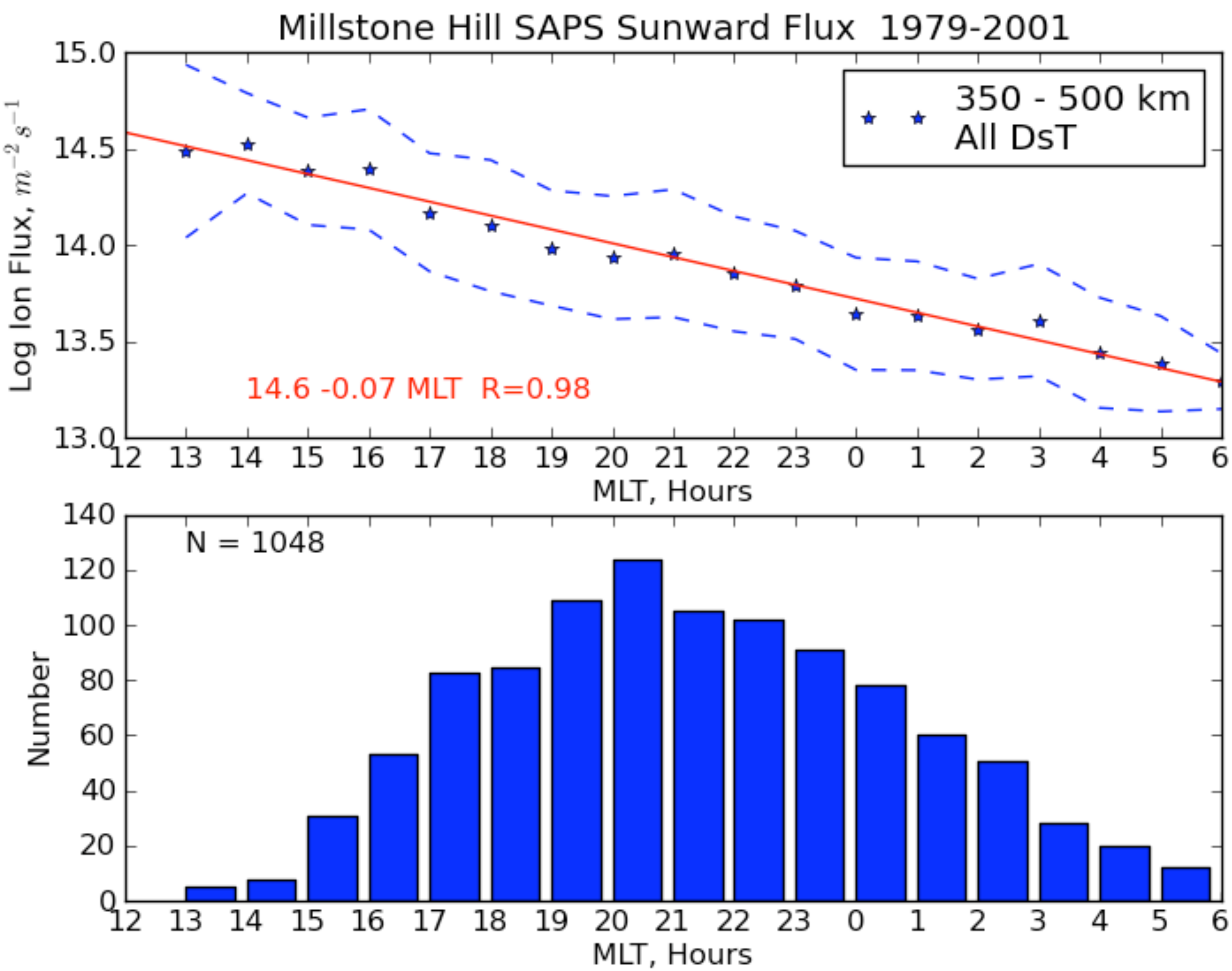
System Regulation: Sunward Flux Invariance



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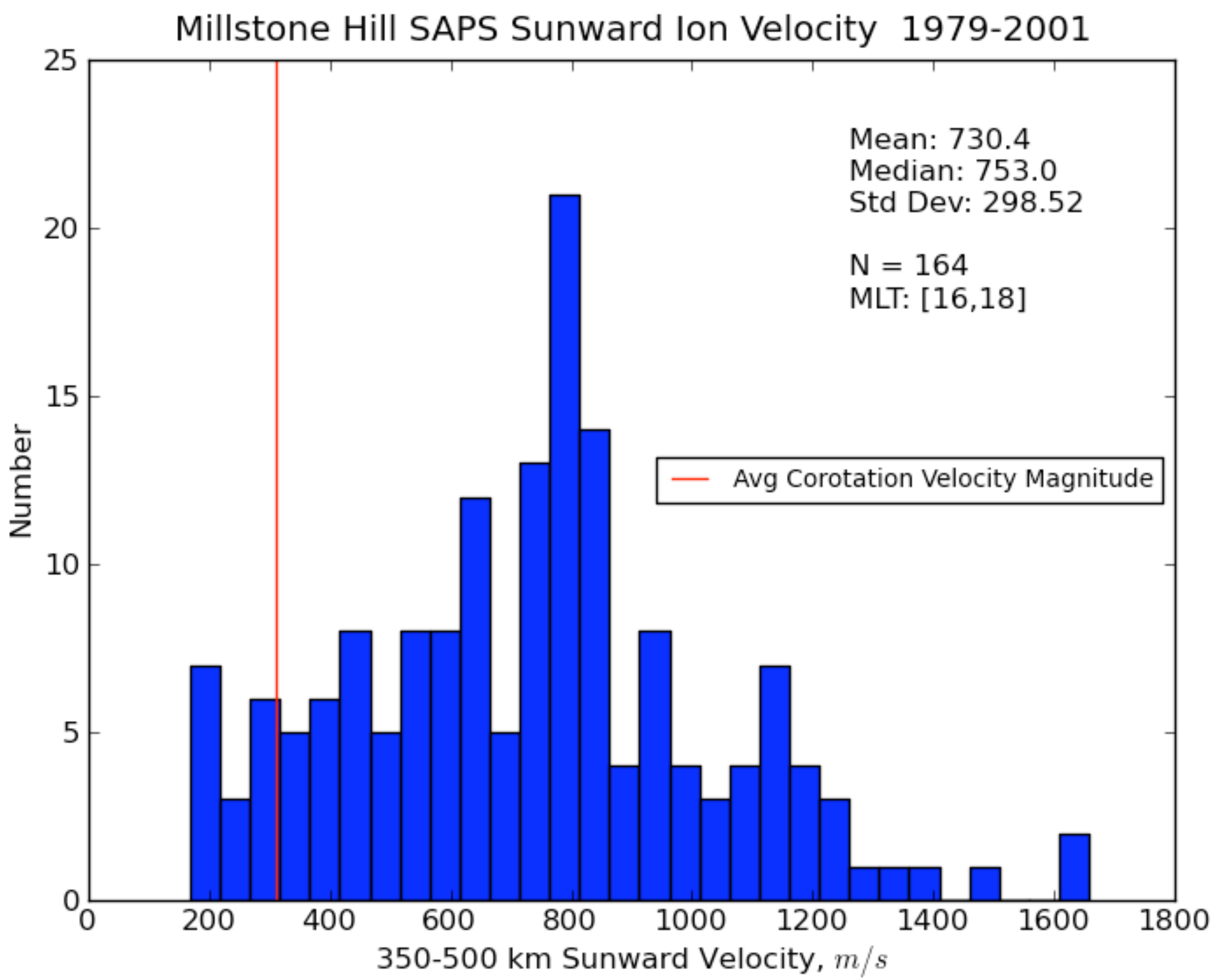
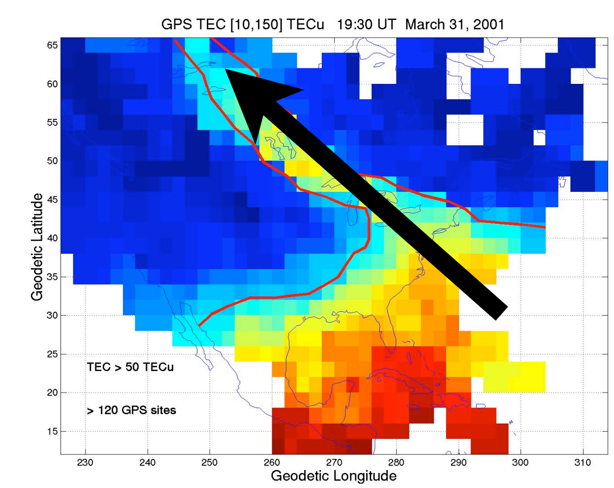
System Regulation: Inertially Fixed Flows



Sunward flow before the terminator moves faster than corotation

(sweeping material westward to the noon cusp)



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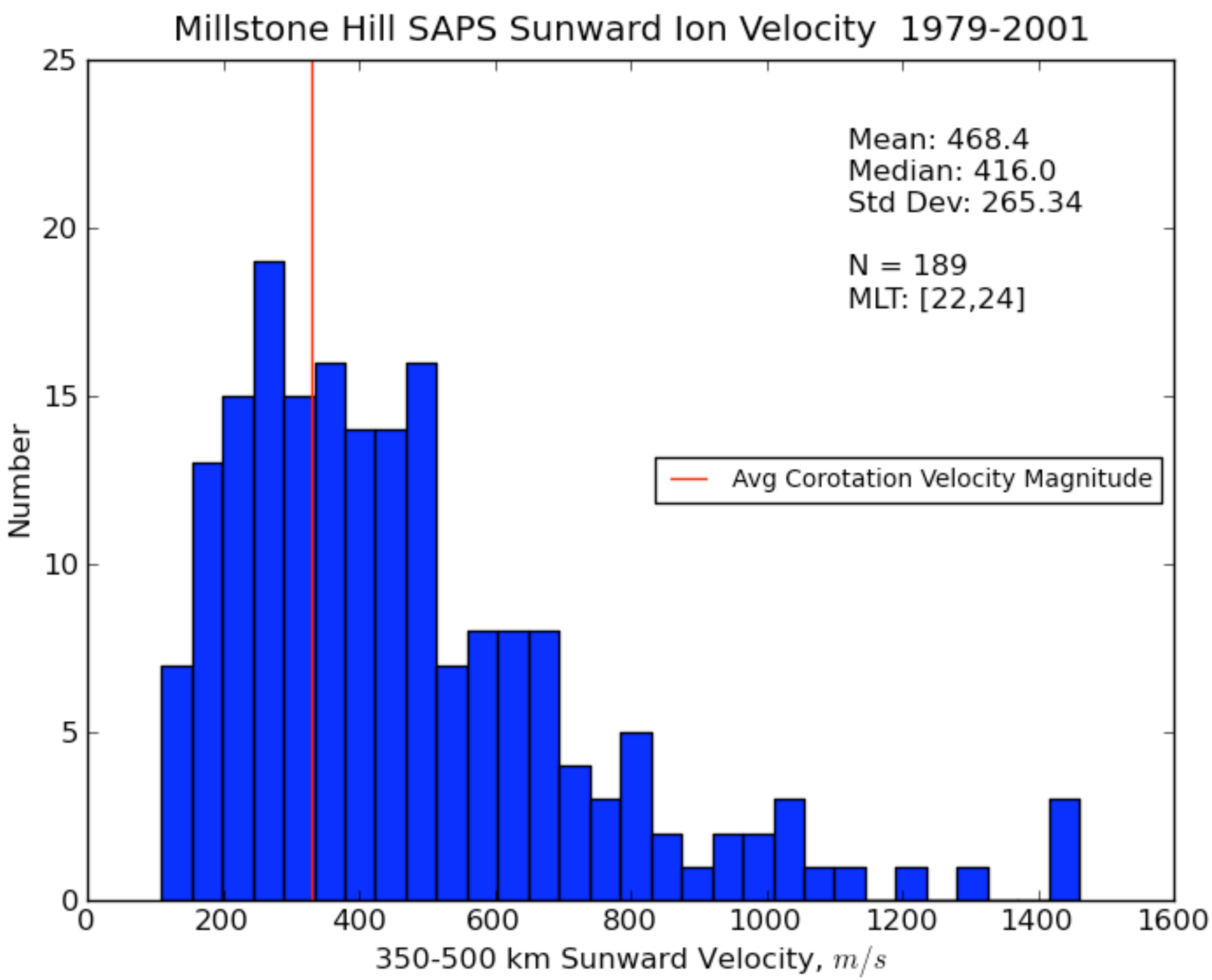
System Regulation: Inertially Fixed Flows

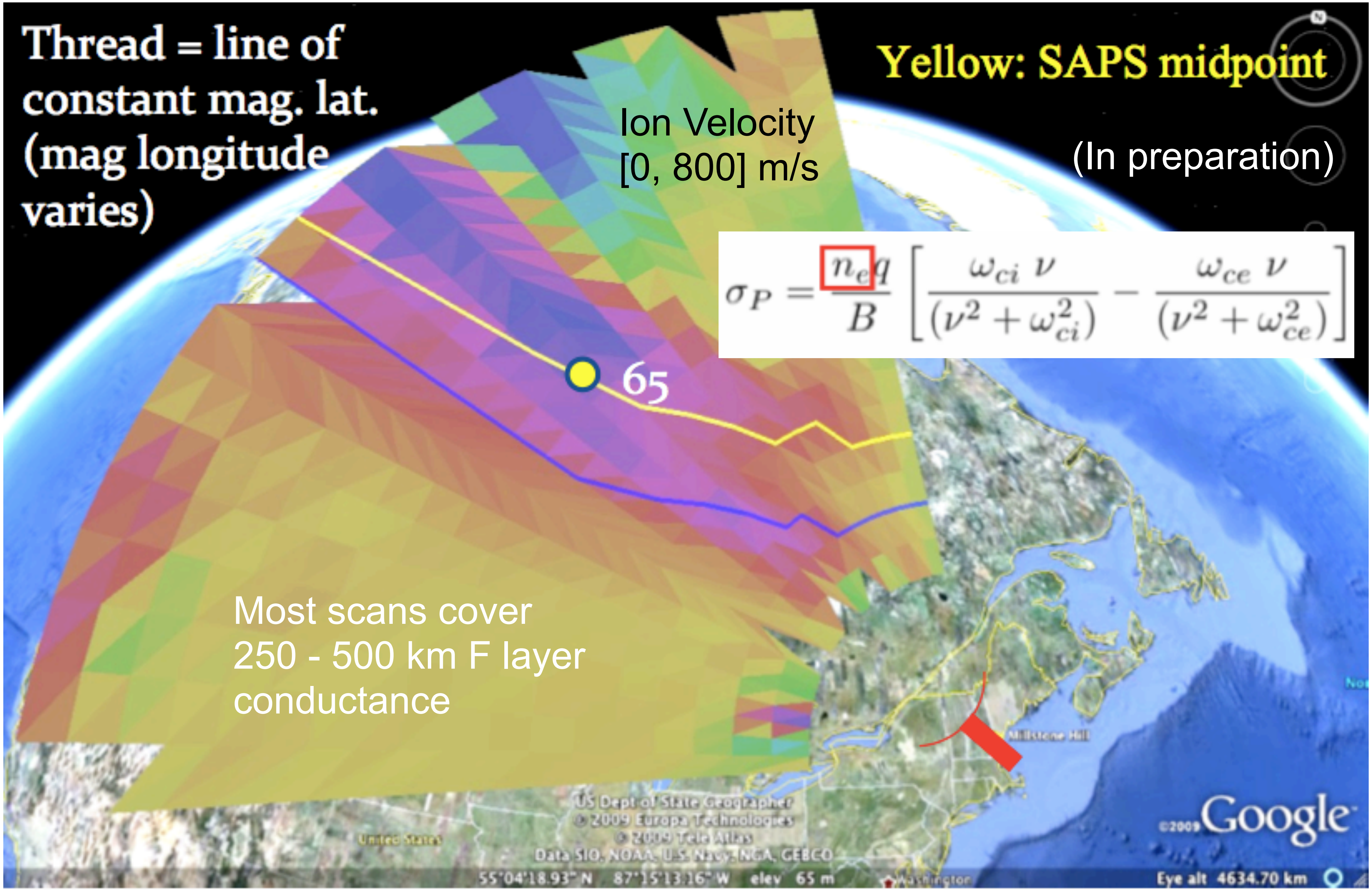


... but after the terminator, flows are nearly opposite corotation

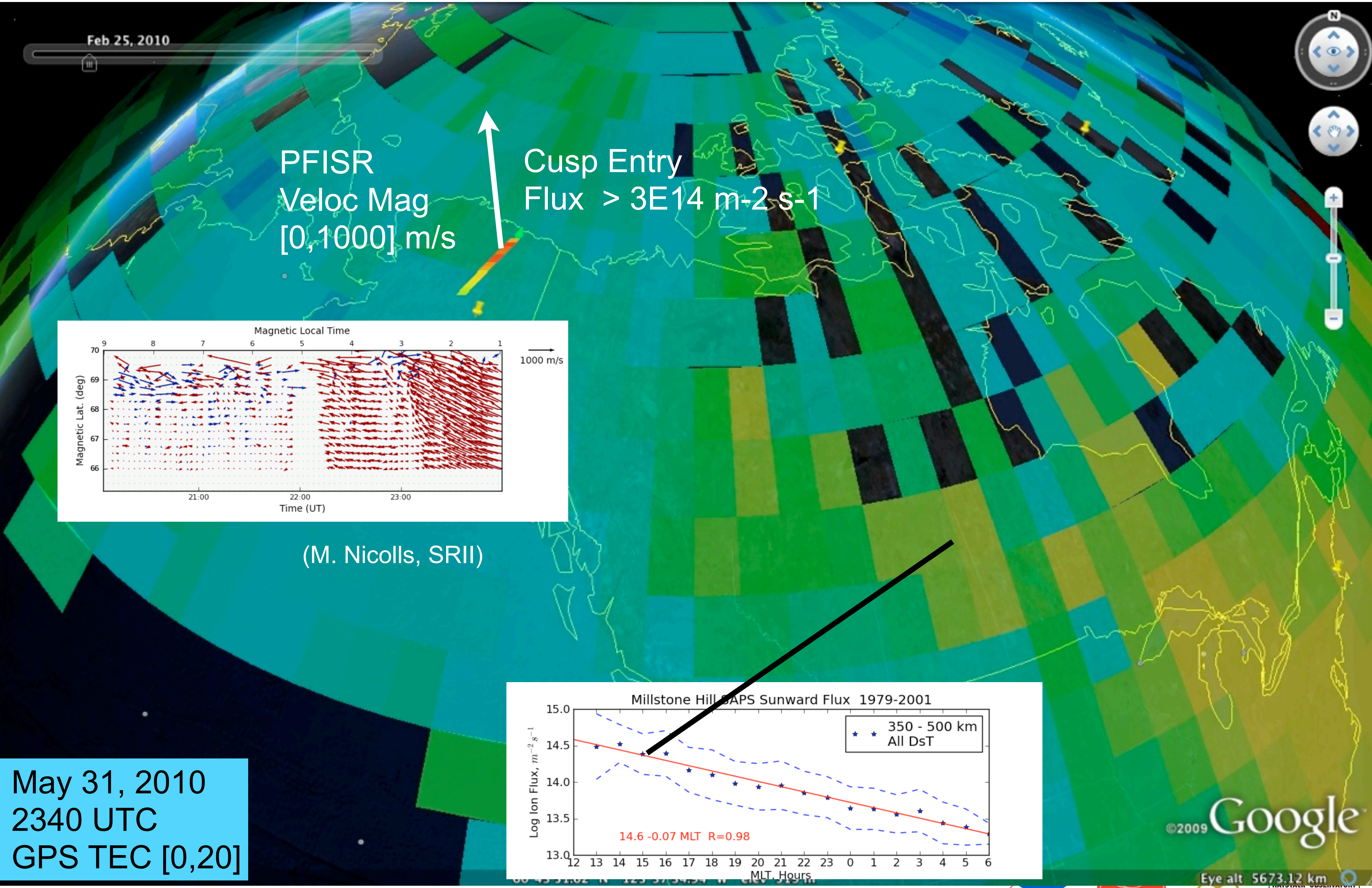
SAPS transport post-sunset is locked inertially at a fixed MLT

Erickson et al submitted JGR 2010

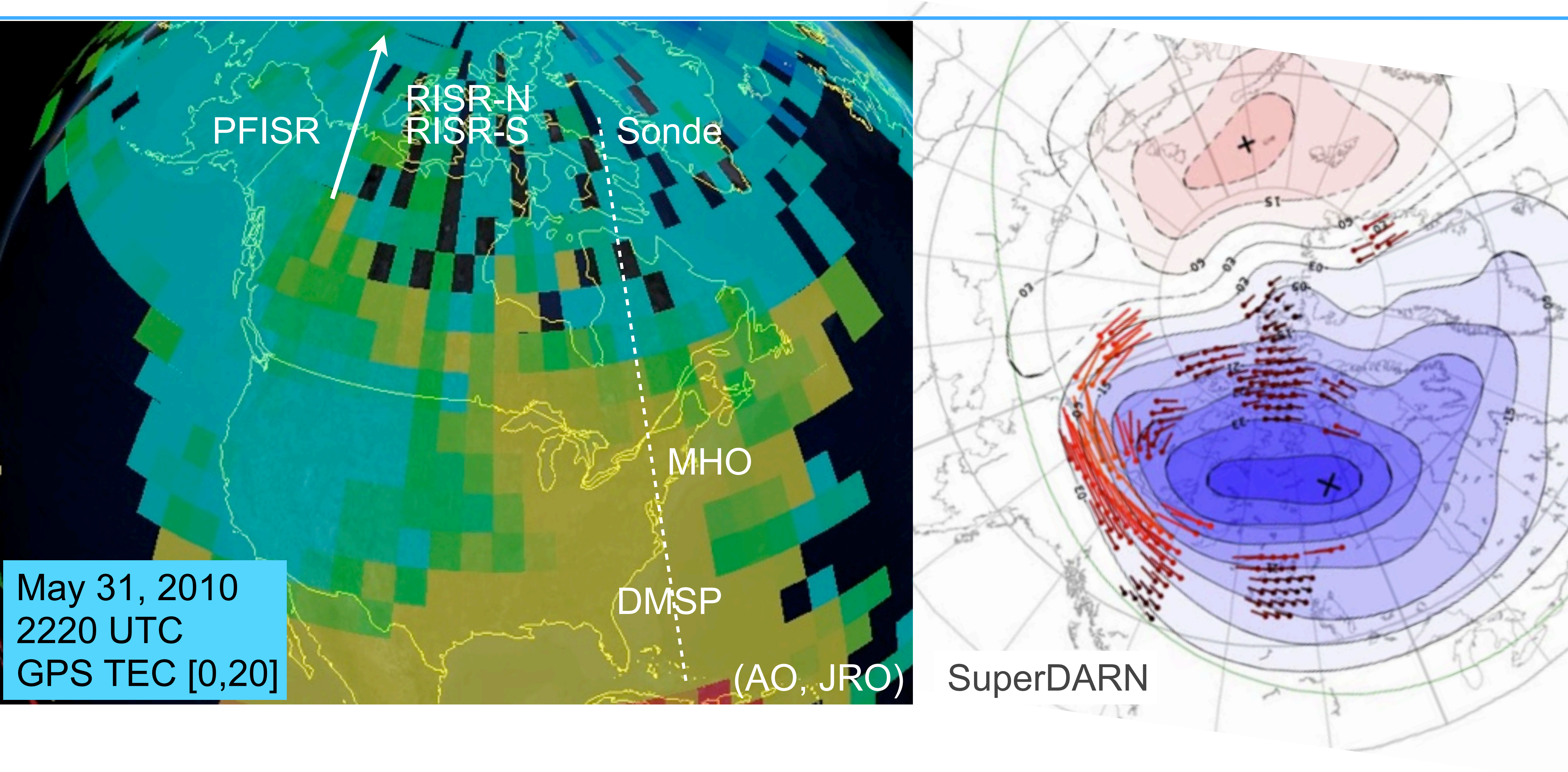
Field-Aligned Integrated Conductance



Geospace Observations: DASI



Geospace Observations: DASI



System Level Responses Require System Level Observations and Science

Summary

- Stormtime ionospheric redistribution is a repeatable phenomenon
- Significant quantities of flux transported horizontally to noontime cusp
- System maintains flux through inverse density/velocity relationship
- System science requires a system and interdisciplinary observational and theoretical perspective

Thanks for your attention!