Incoherent Scatter Radar (ISR) PBL Diagnostics

ISRs are really good at plasma parameter profiles for evaluation of temperatures, densities, ion fluxes, ion composition, ...

Intriguing PBL features to investigate further:

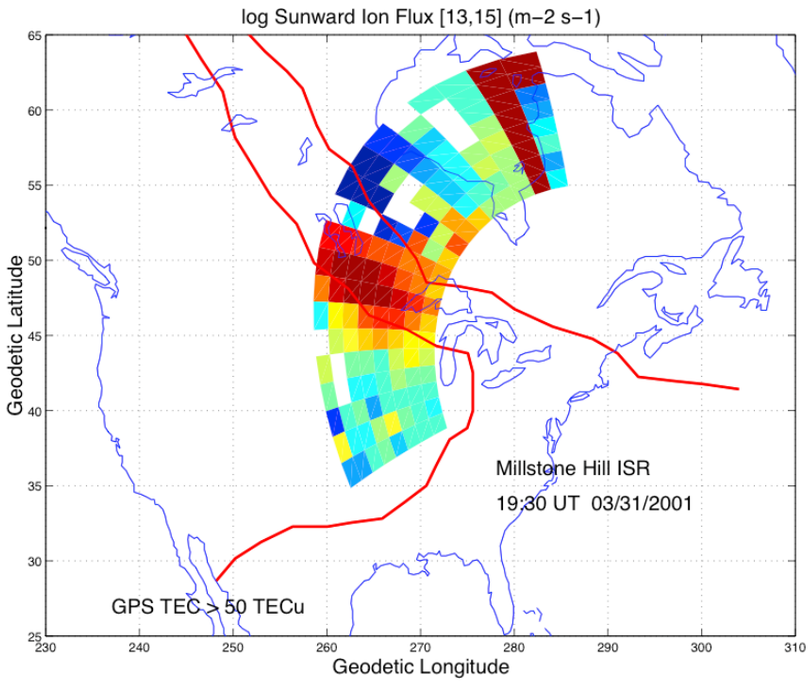
1. Inverse density/velocity feature within SAPS
2. Westward flux invariance to disturbance level
3. Temperature increase in SAPS channels

Others (which I will not cover here):

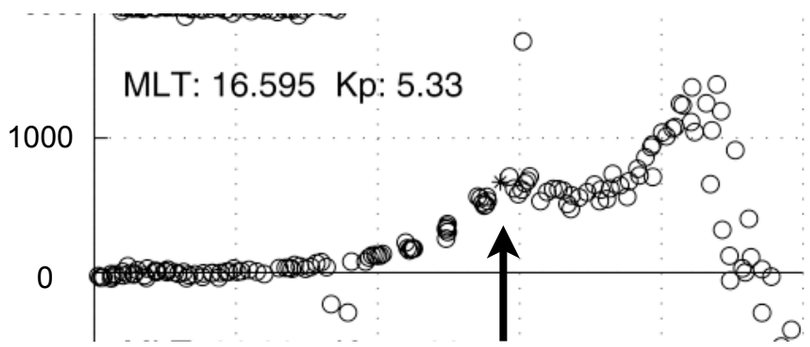
- Density preservation by uplift as material moves into cusp
- Quantitative horizontal flux transfer to high latitudes: big enough to provide a source of heavy O+ ion outflow and polar cap patches?
- Quantitative study of impacts of ionospheric conductance on SAPS channels
- Detailed comparison of electric field, FAC features in the ionosphere and plasmasphere. Efficiency of conjugacy?
- Relation of SAPS flow channels to substorm onsets and particle injections (see Lyons / Nishimura)
- Instantaneous MLT dependence of SAPS fluxes? (Requires more ISRs..)

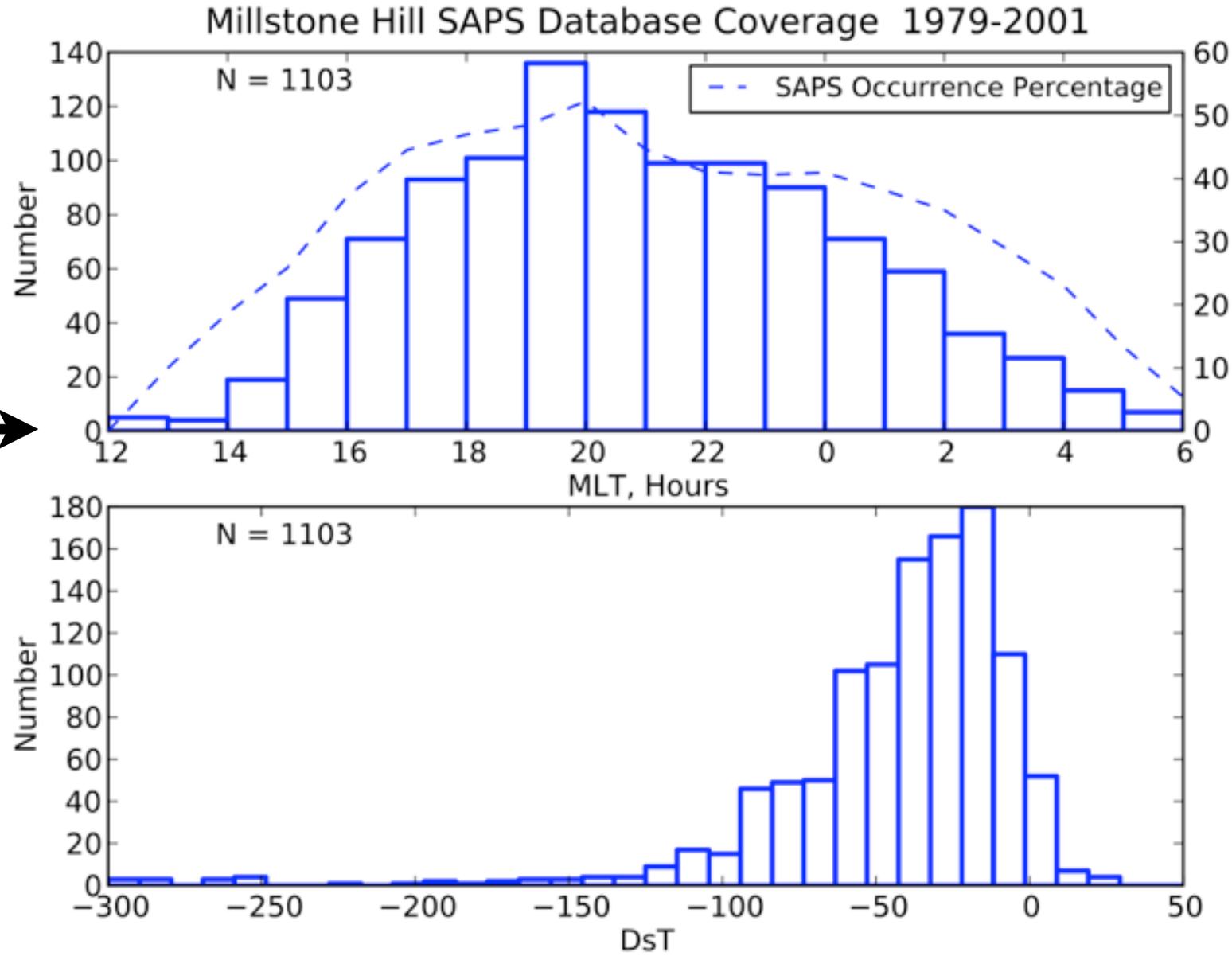
Mid-Latitude Flows: SAPS Statistical Study

Individual events



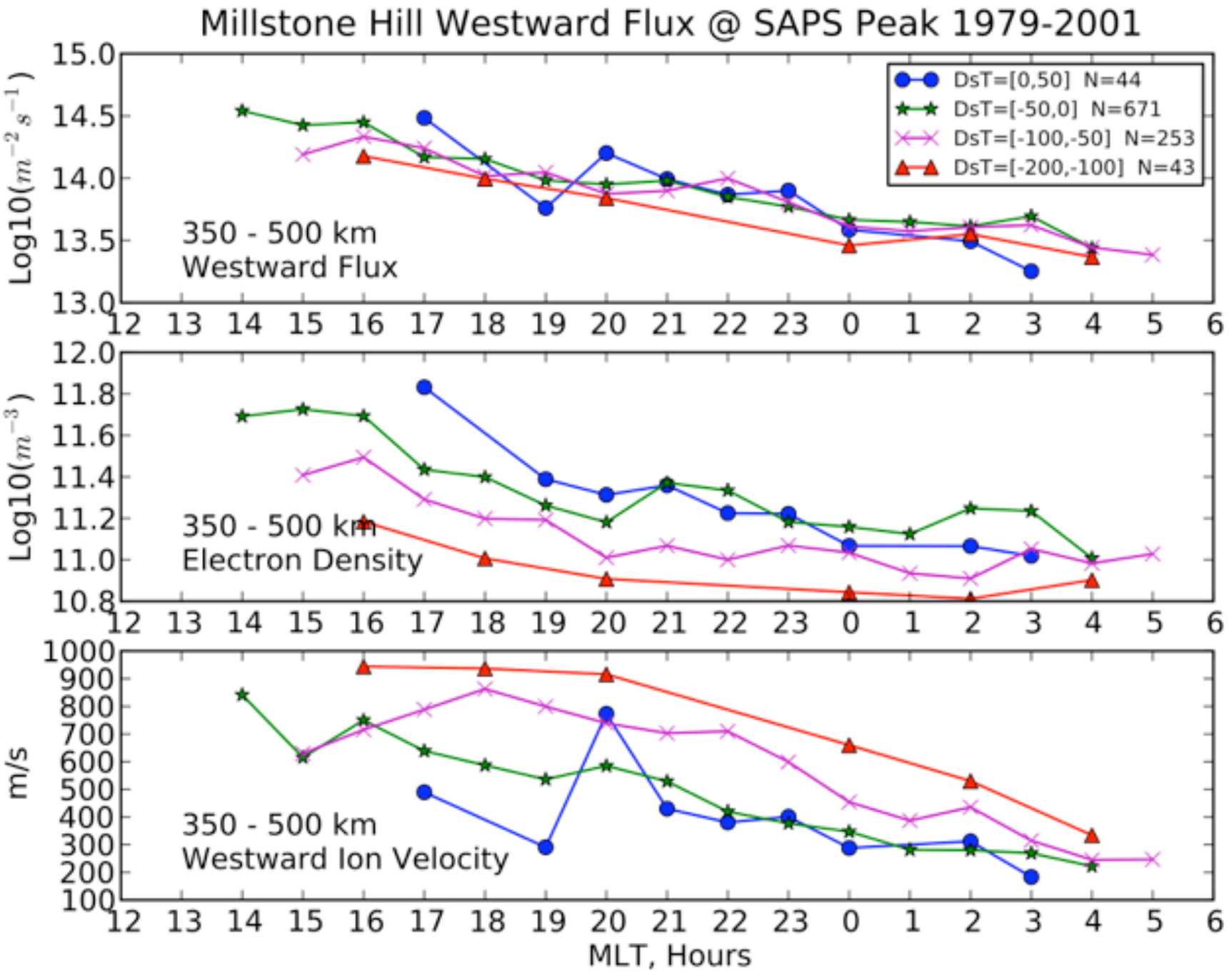
Westward ion velocity, m/s



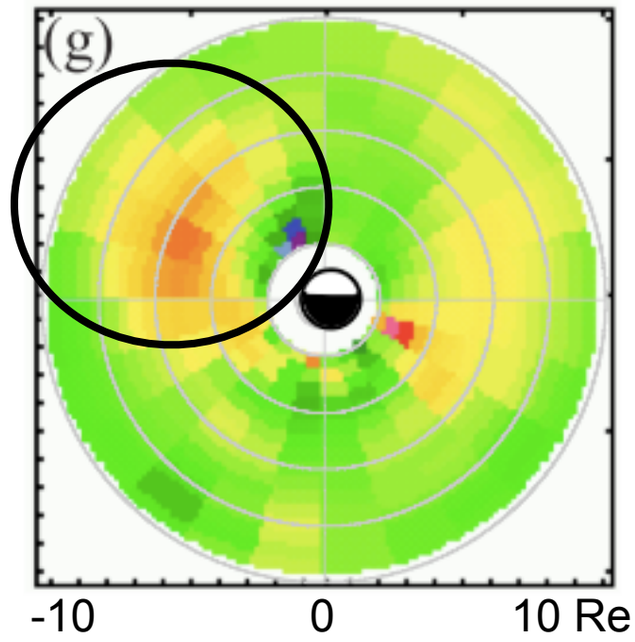


Kp = 2 and greater
10,000+ scan database

SAPS Flux: Inverse Density/Velocity Relation



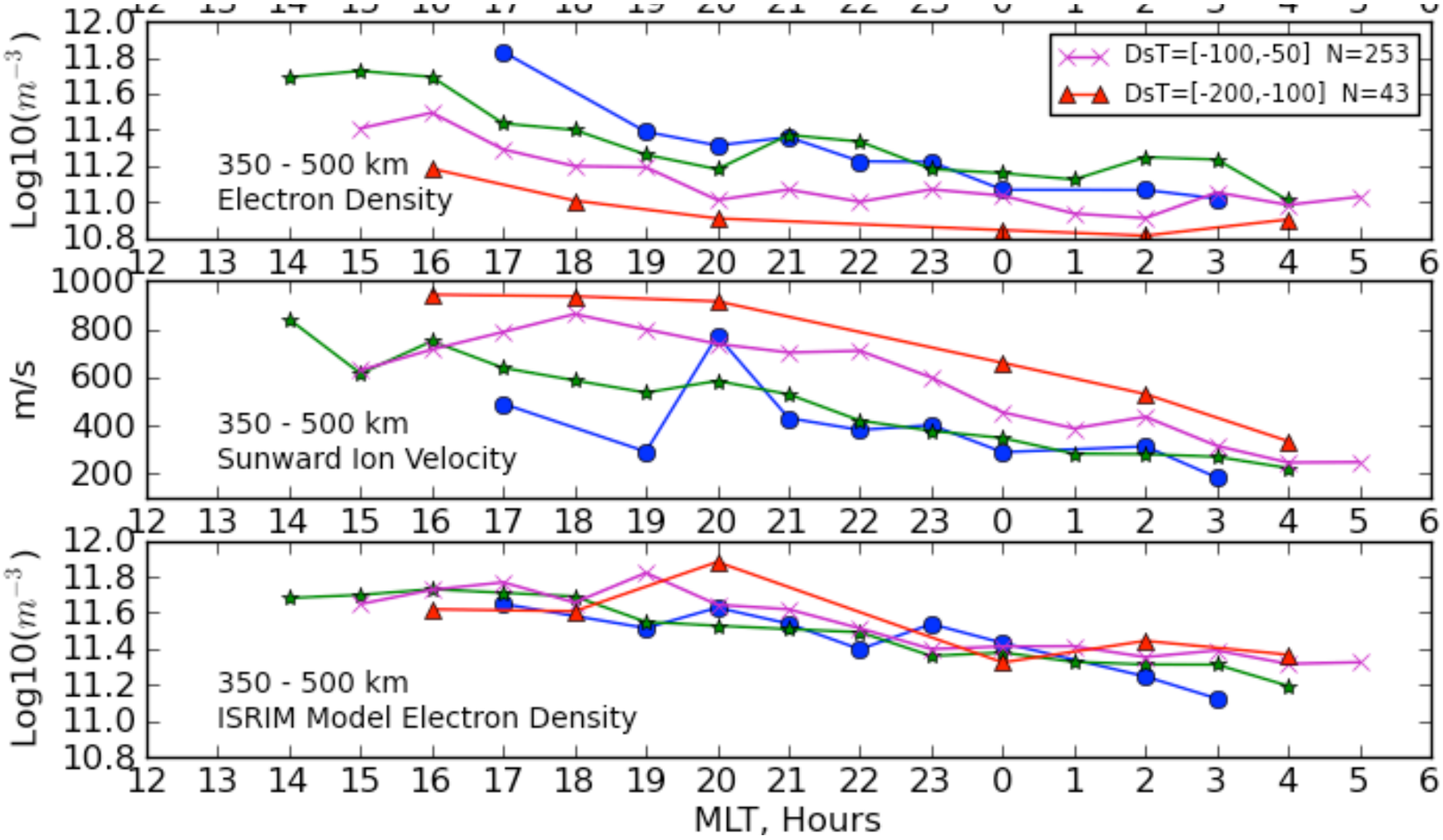
Ey [-4, 4] mV/m
Recovery phase



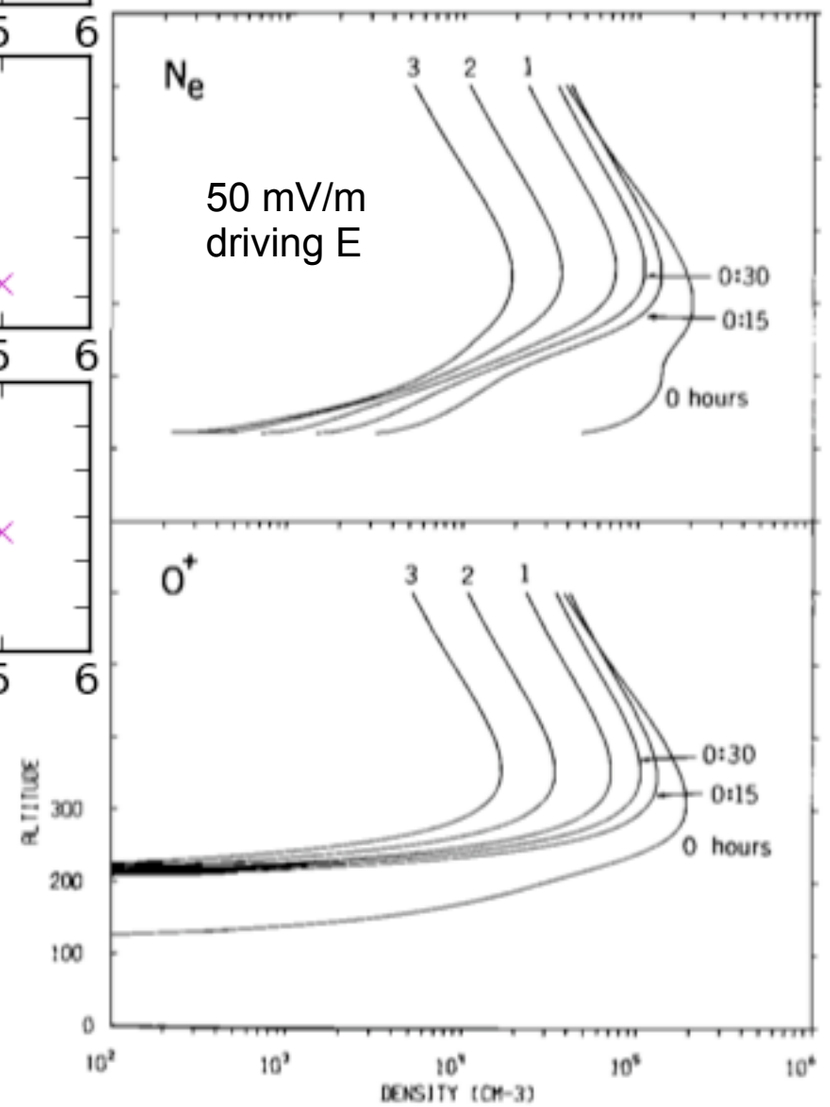
Nishimura et al, 2006
(Akebono data)

Erickson et al
JGR 2011

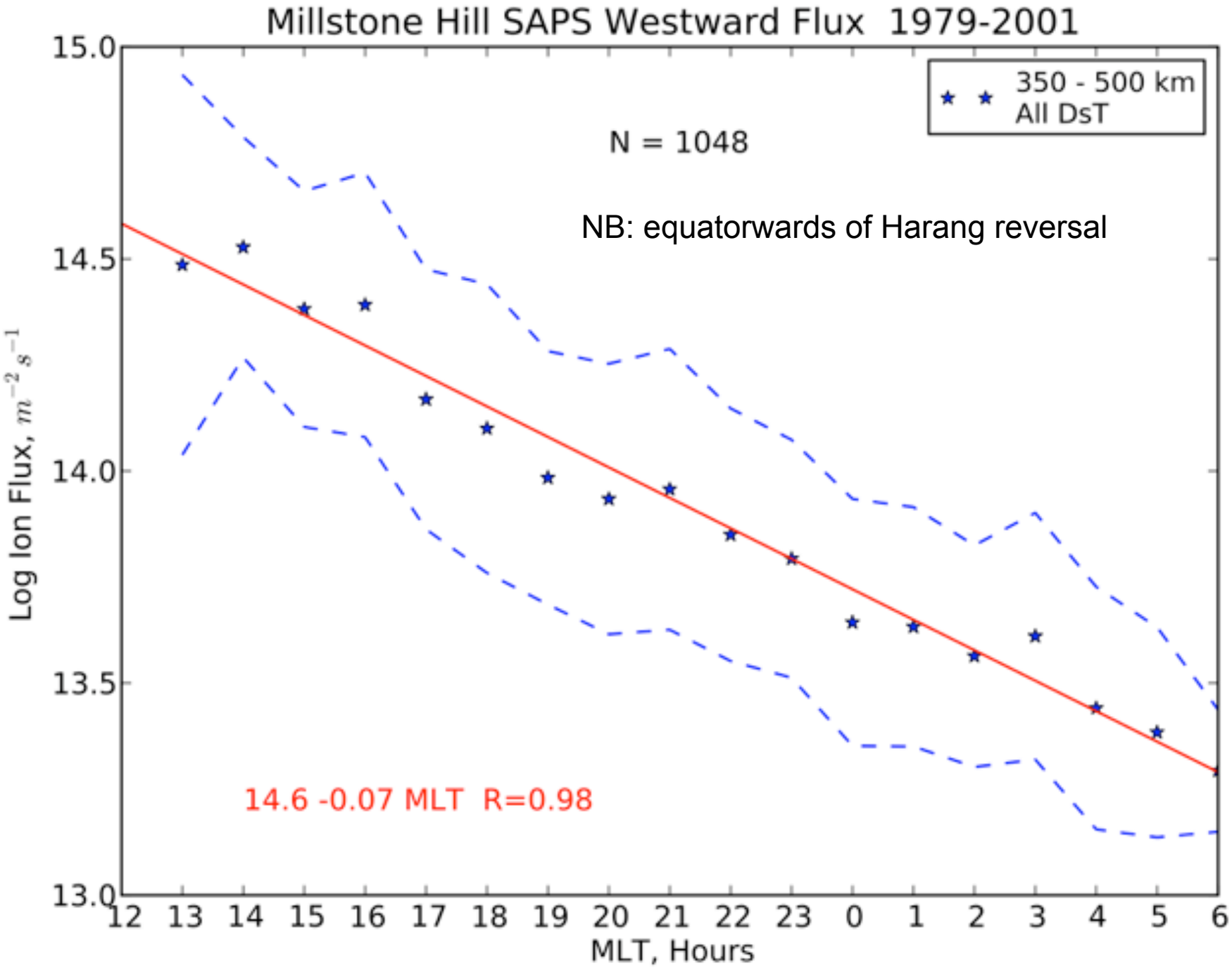
SAPS Flux: Inverse Density/Velocity Relation



Schunk et al 1976

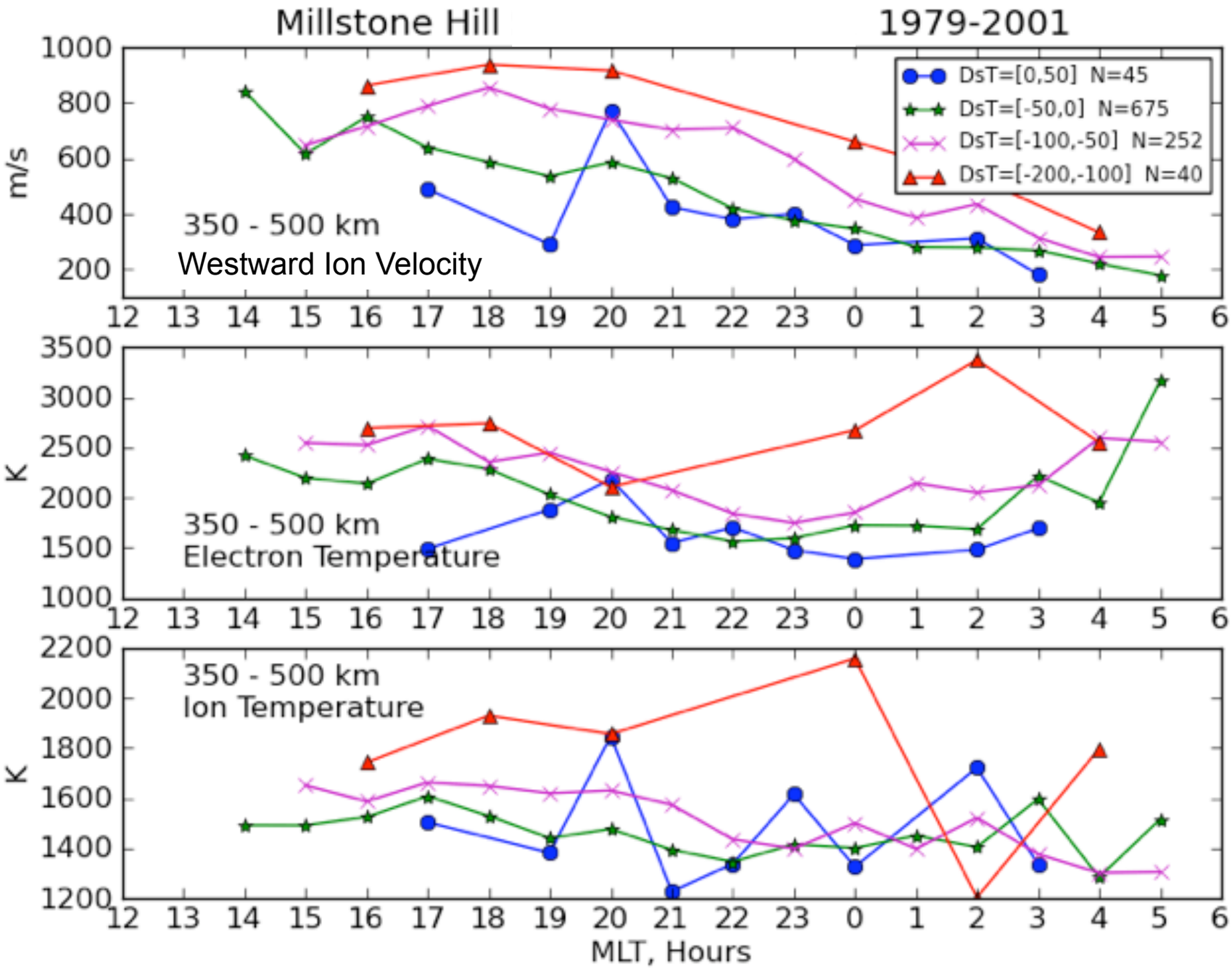


System Regulation: Westward Flux Invariance



Erickson et al
JGR 2011

SAPS Temperature Enhancement



@ 50 mV/m driving E
(1 km/s westward flow):

Te increase
~800-1000 K

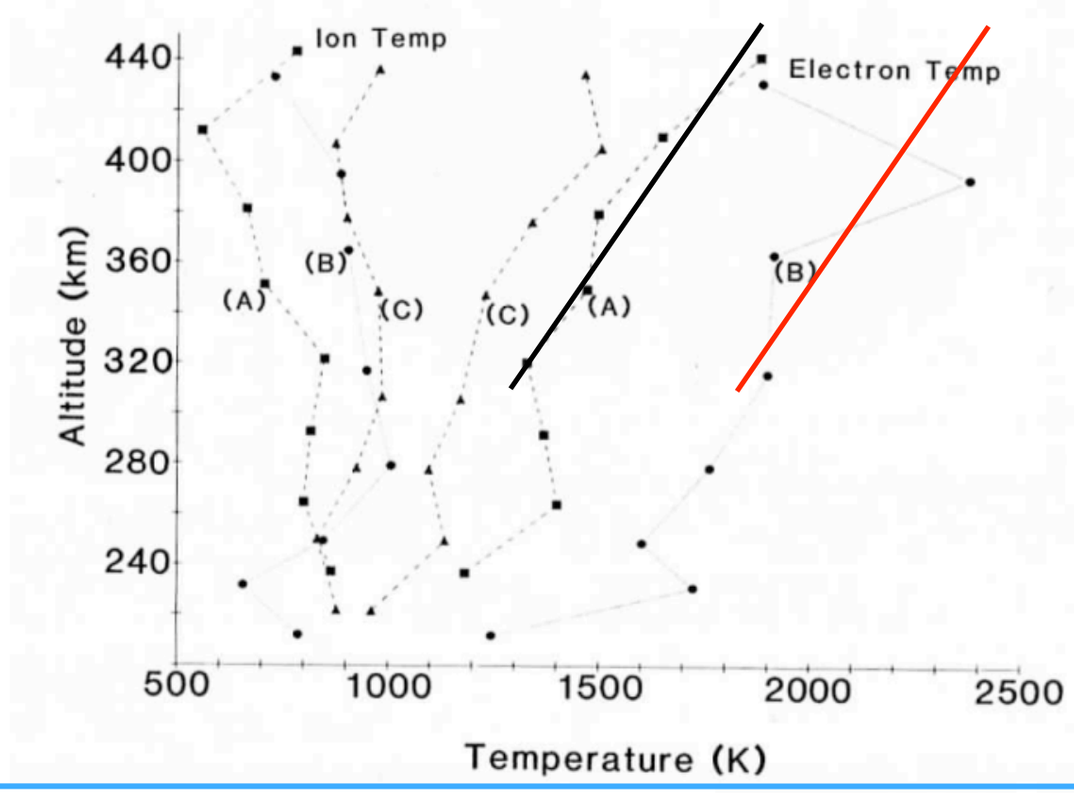
Ti increase
~400-600 K

SAPS Temperature Enhancement: Causes

TABLE 1. Ionospheric Parameters

$E_\perp'$, mV m^{-1}	T_i, °K	T_{eff}, °K	$h_m(N_e)$, km	$N_m(N_e)$, cm^{-3}	$h_t(NO^+, O^+)$, km
0	994	994	290	1.85(5)	225
25	1,186	1,223	290	1.66(5)	230
50	1,754	1,837	190	1.29(5)	255
100	4,290	4,624	190	1.24(5)	325
200	14,435	15,770	190	1.23(5)	

1.85(5) = 1.85×10^5.



Schunk et al 1975:
Ti increase by frictional heating

Mendillo et al 1987:
Ring current Te heating in SAR arcs

SAPS Te enhancement likely
too weak for SAR arcs

Also possible:
Some frictional enhancement - e.g.
~400 K for 30 mV/m @ 350 km alt
(Baumgardner et al, 2009)

$$\Delta T_e = \frac{m_i}{3kB^2\left[\left(\upsilon_{in}/\Omega_i\right)^2 + 1\right]} E^2$$