

Comparative Aeronomy at Earth and Mars

Paul Withers

Boston University

(withers@bu.edu)

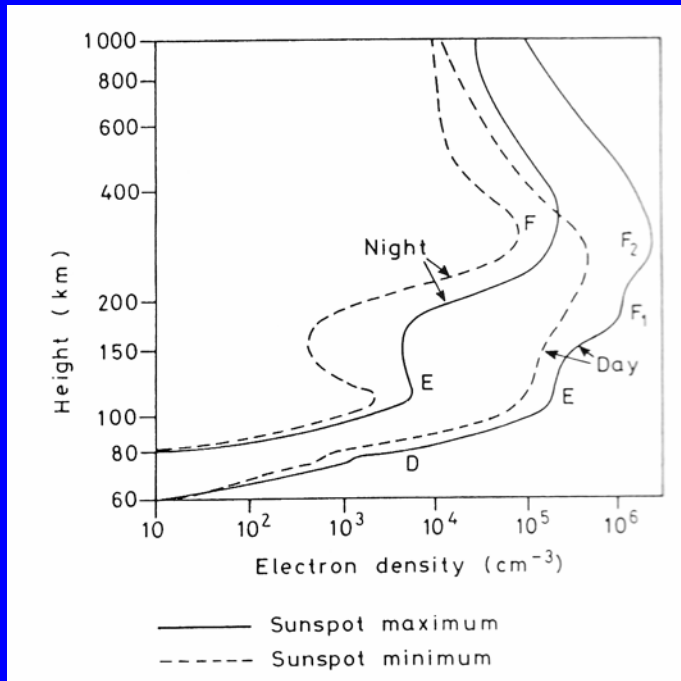
In collaboration with Michael Mendillo and BU
colleagues, David Hinson, and Henry Rishbeth

CEDAR Postdoc Talk

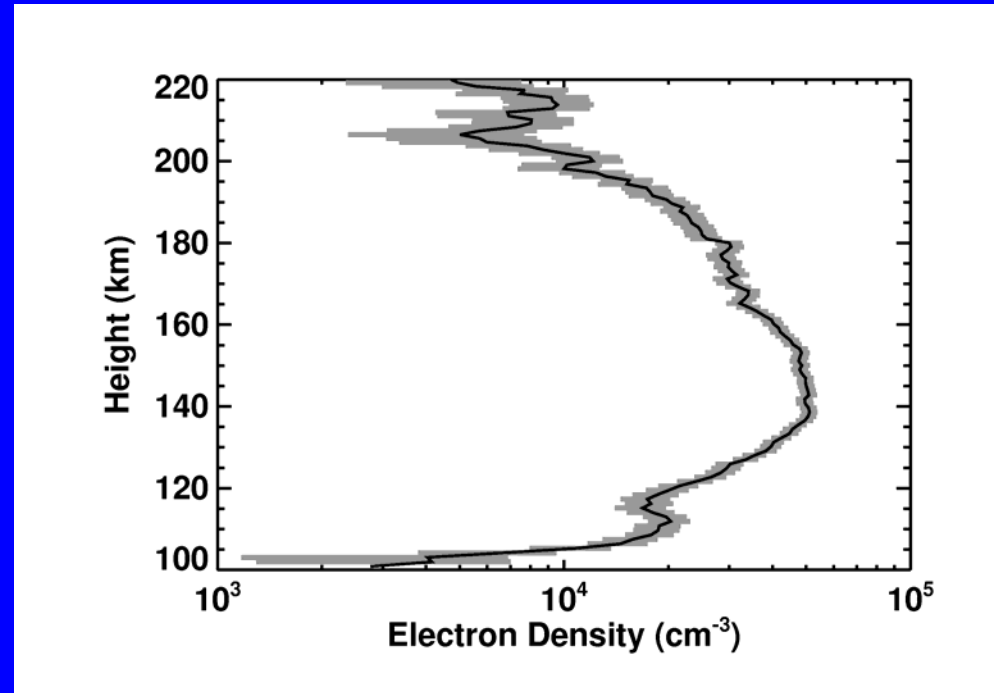
Wednesday 2006.06.21 9:20 – 9:35

CEDAR Meeting 2006, Sante Fe

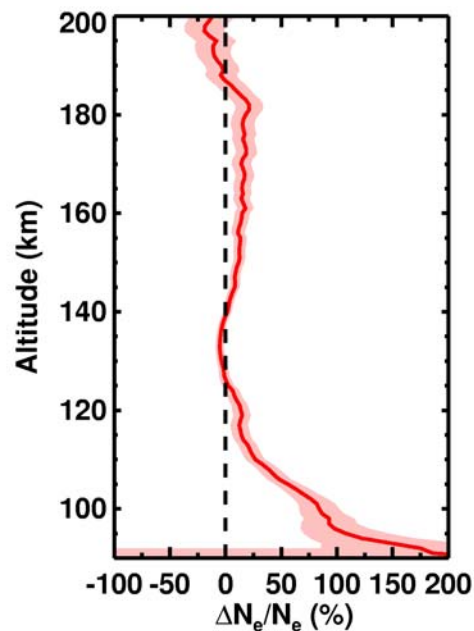
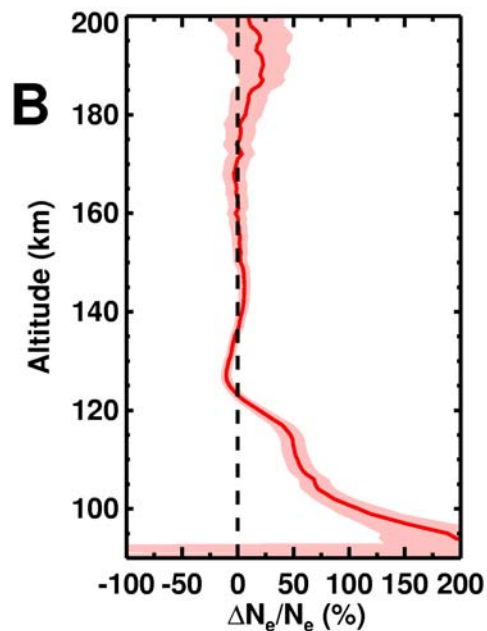
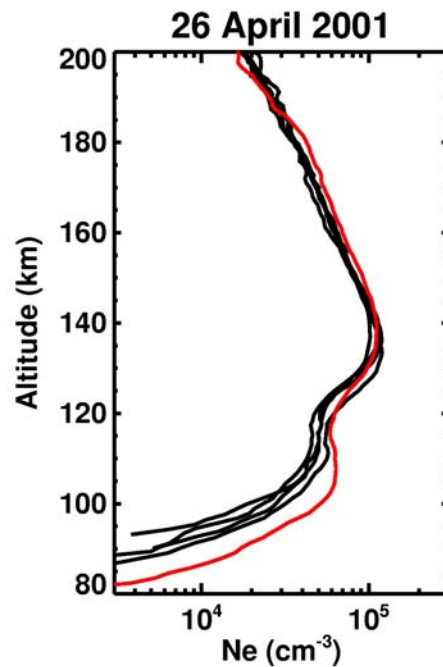
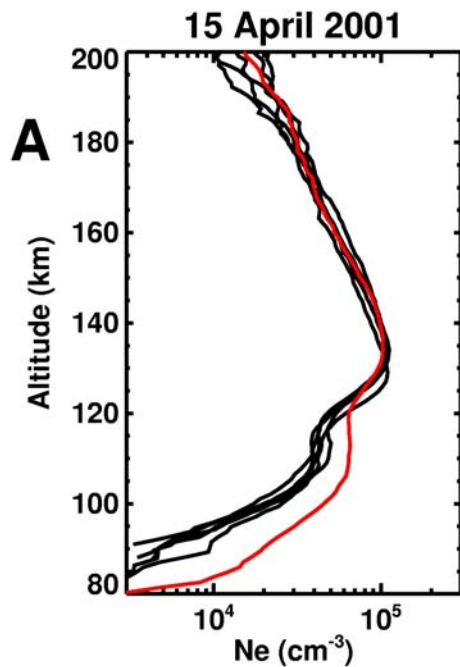
Typical Ionospheric Profiles



Earth (Hargreaves, 1992)
F layer due to EUV photons
E layer due to soft X-rays
D layer due to hard X-rays
Soft ~ 10 nm, hard ~ 1 nm



Mars (MGS RS data)
Main peak at 150 km due to EUV photons
Lower peak at 110 km due to X-rays. Lower peak is very variable and often absent



MGS electron density profiles
from 15 and 26 April 2001

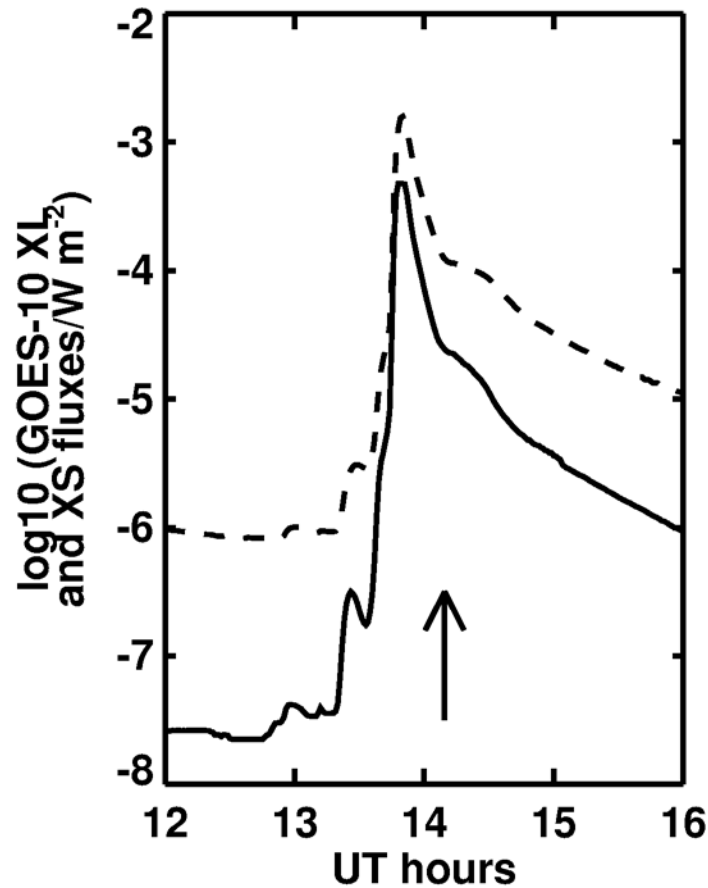
One profile on each day shows
enhanced electron densities at
low altitudes (red)

Percentage difference between
the enhanced profile and the
average non-enhanced profile

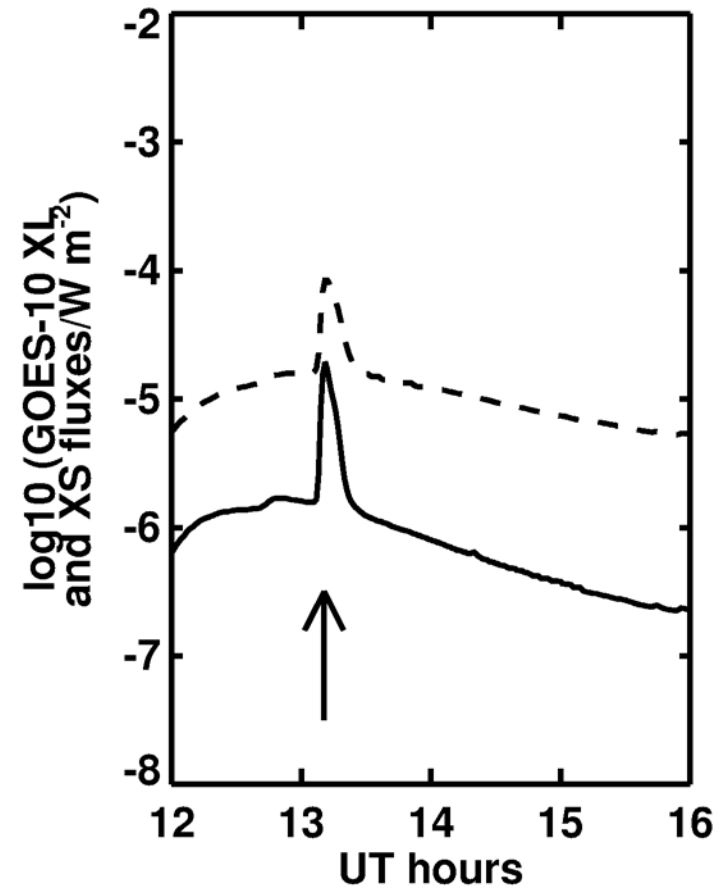
No difference above 120 km
100% difference at 100 km, so
densities have doubled

Difference increases as
altitude decreases

15 April 2001



26 April 2001



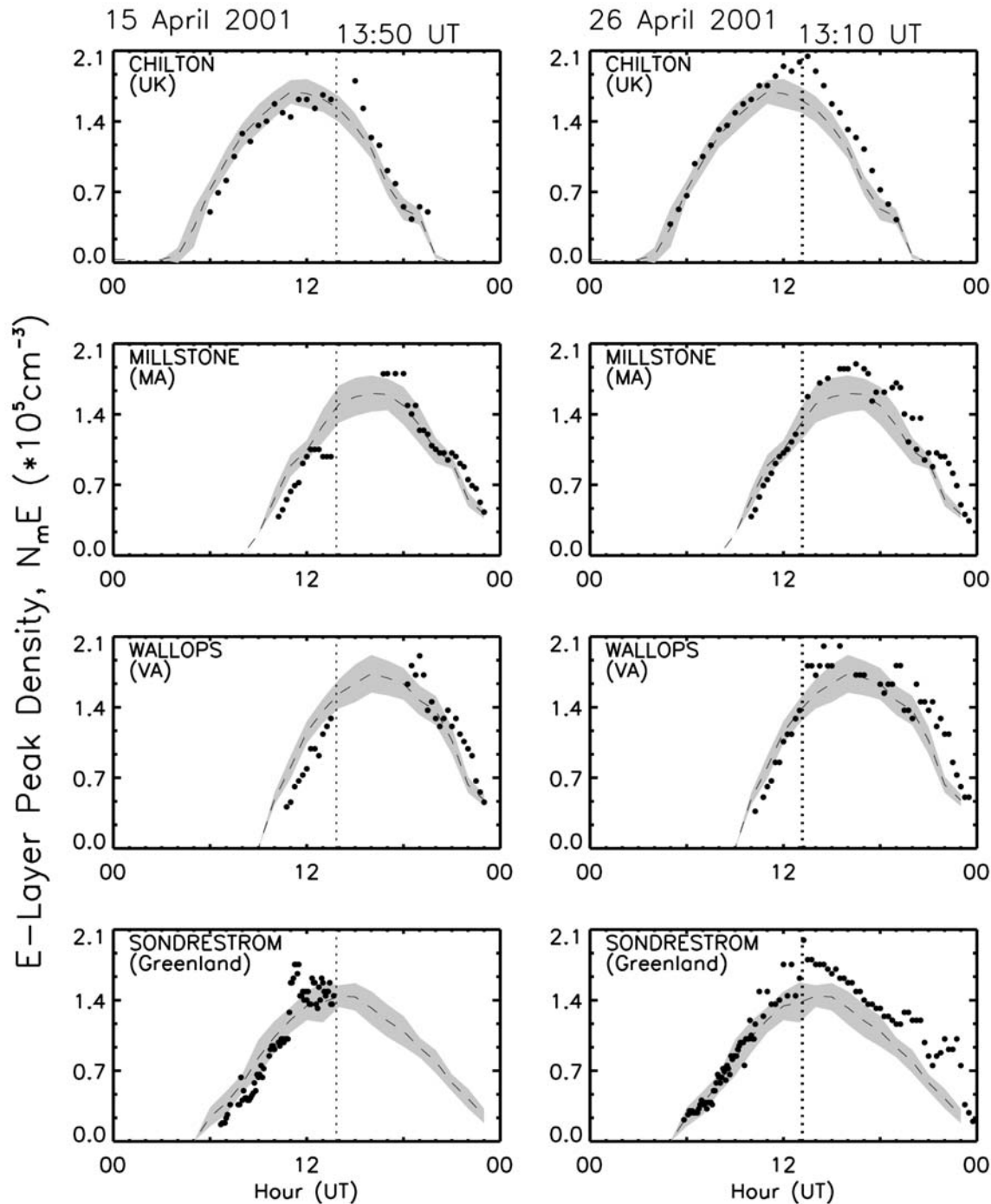
Solar flux at Earth measured by GOES satellites

Dashed line is 1 – 8 A, solid line is 0.5 – 3 A

Arrow marks the time of the enhanced profiles at Mars

15 April = X14.4 flare

26 April = M7.8 flare



Plots of NmE versus UT for Chilton, Millstone, Wallops, and Sondrestrom on 15 and 26 April

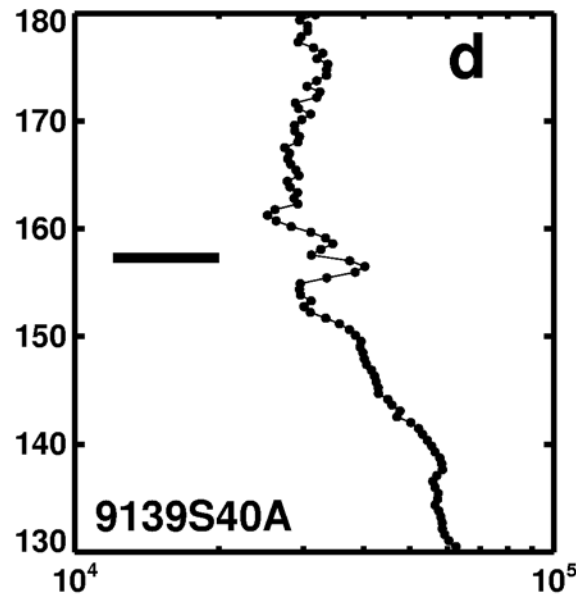
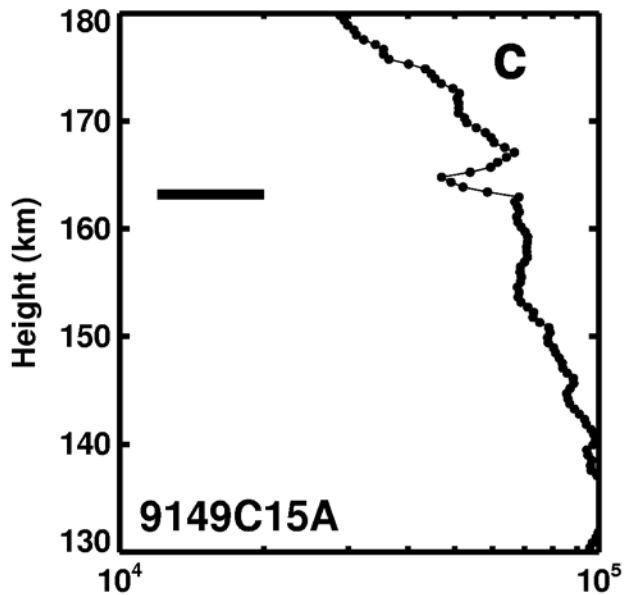
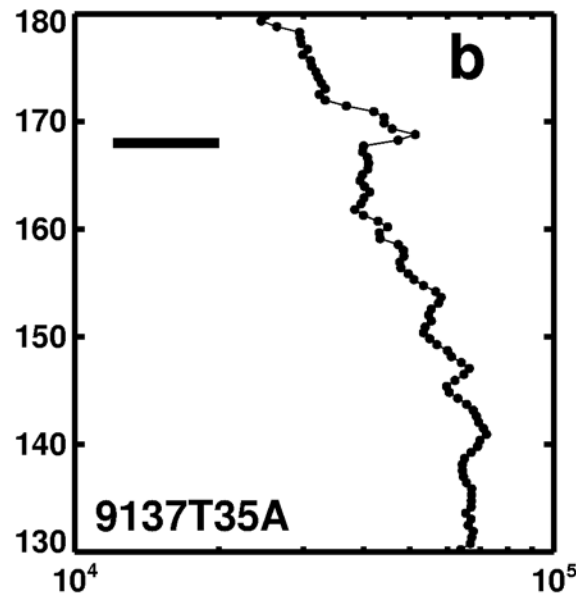
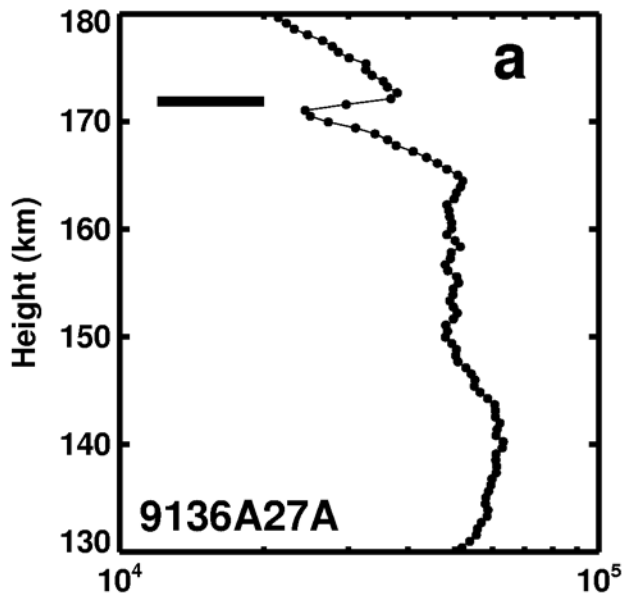
Shaded areas represent one standard deviation about the mean for April 2001

Dots are ionosonde measurements

Vertical dotted line marks time of solar flare

No data after X14.4 flare on 15 April

NmE increased after M7.8 flare on 26 April

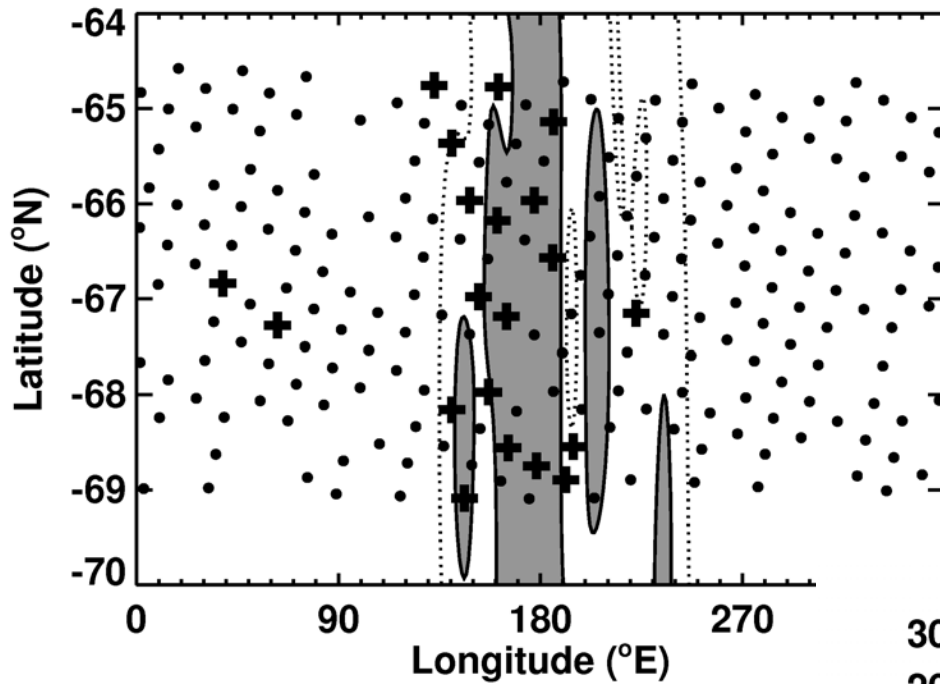


Some MGS profiles show biteouts or bumps

Very short vertical lengthscale

Caution: Data from spacecraft to Earth radio occultation, not from ionosonde

Only found in regions where the magnetic field is strong

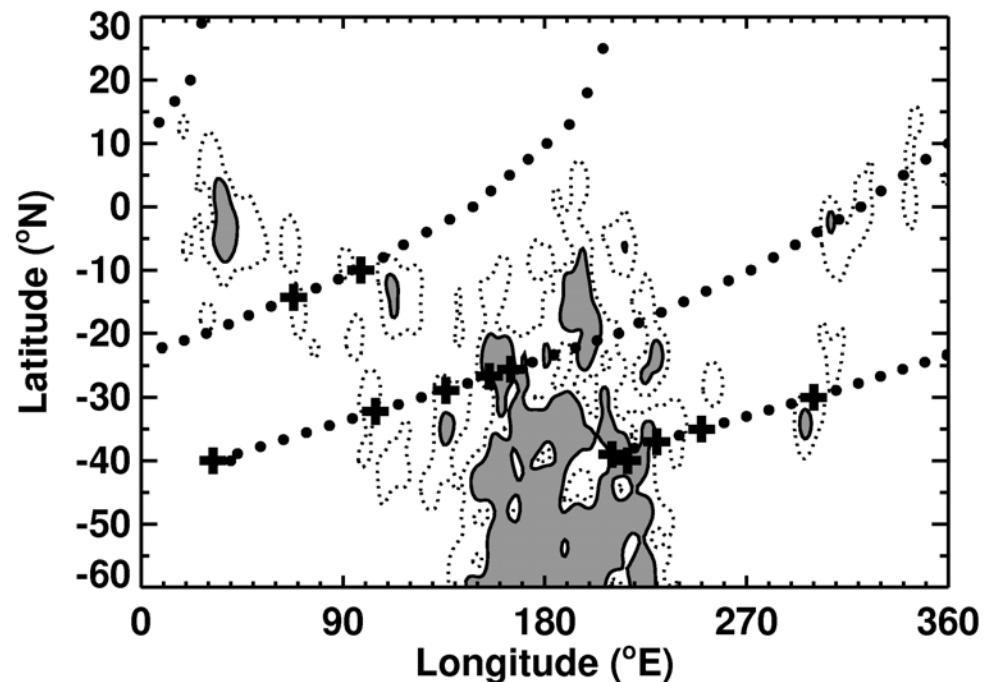


Mars magnetic field is not global dipole. Sources are old crustal rocks.

MGS data to the left
Very restricted latitude range

Shaded regions have $B > 100$ nT
at 150 km

Mariner 9 data from 1971-2 on right
Same biteouts seen in these data



Conclusions

- Parameterizations of secondary ionization can be tested on Earth and Mars simultaneously
- Flares are nice because the photon flux and photochemistry changes from solar min to solar max conditions, while the neutral atmosphere doesn't change.
- Mars ionosphere is affected by magnetic fields. How will plasma instabilities, currents, and dynamos behave in a non-global magnetic field?