Observations of the nightside ionosphere of Mars by the Mars Express Radio Science Experiment MaRS

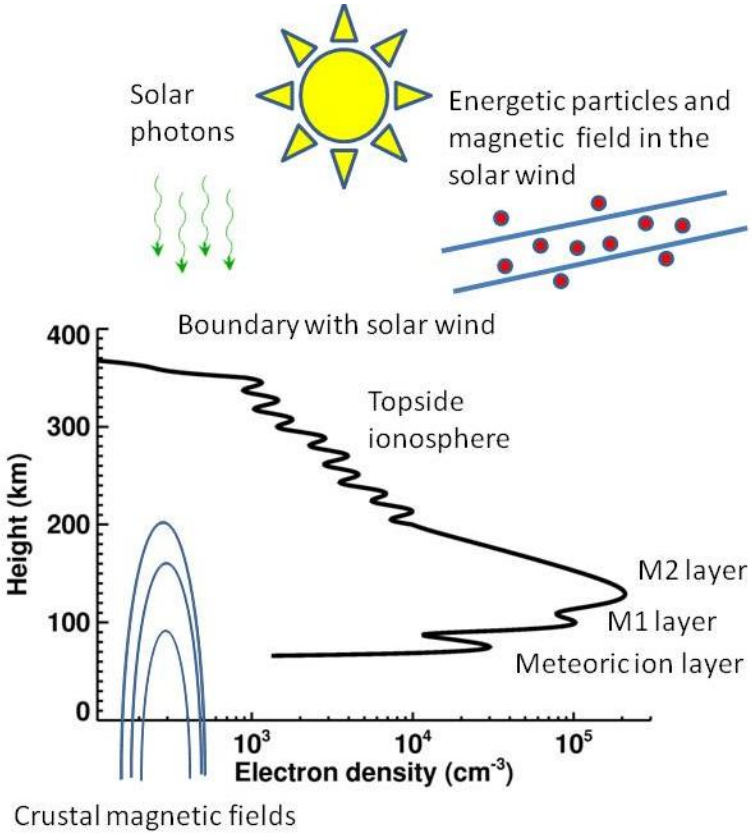
M. Patzold, Paul Withers, M. Fillingim,
R. Lillis, B. Hausler, D. Hinson, L. Tyler,
K. Peter, S. Tellmann, and O. Witasse

Abstract SA44A-07
withers@bu.edu

Fall AGU meeting
San Francisco, California
2012.12.06, 1730-1745

Day and night

Dayside



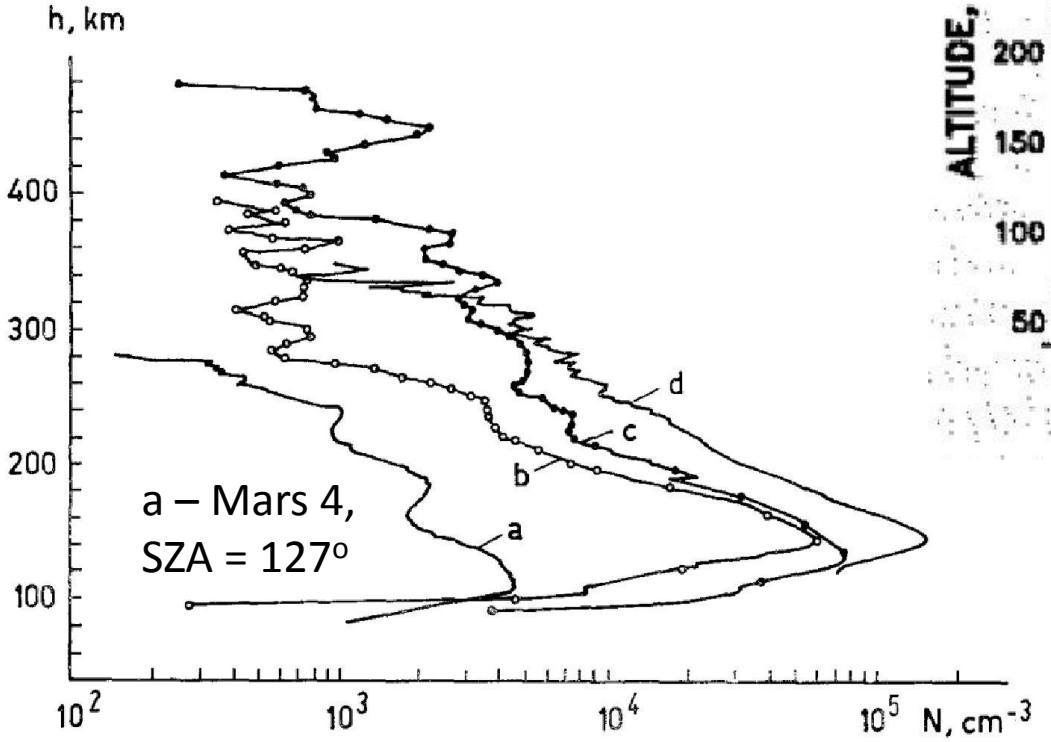
- Nightside
- At 0 km, the sun sets at solar zenith angle (SZA) of 90 degrees
- At 120 km, it sets at 105^o

Nightside plasma sources are

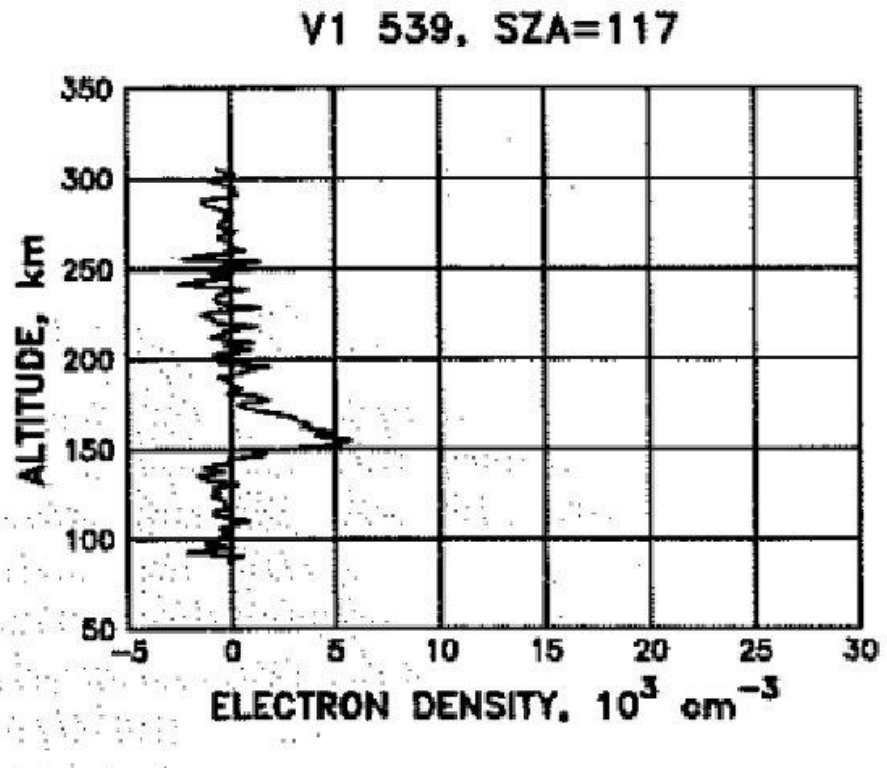
- Transport from dayside
- Electron precipitation

Previous nightside (SZA>105°) data

About 10 profiles detected plasma
Few of them published, none archived



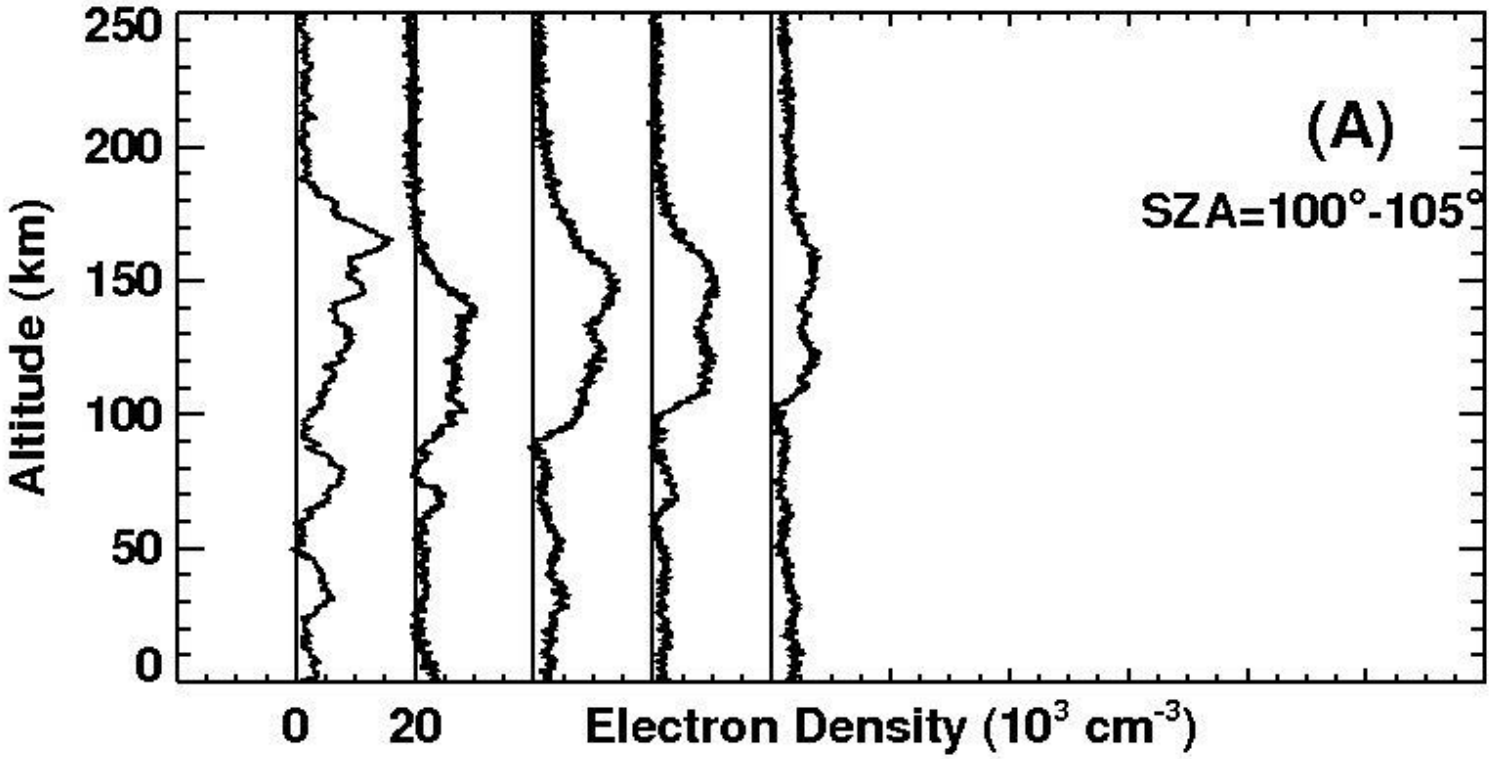
Moroz (1976) Fig 31



Zhang et al. (1990) Fig 1a

Peak densities ~ 5E3 cm^{-3}
Peak altitudes ~150-180 km

Last remnants of dayside ionosphere



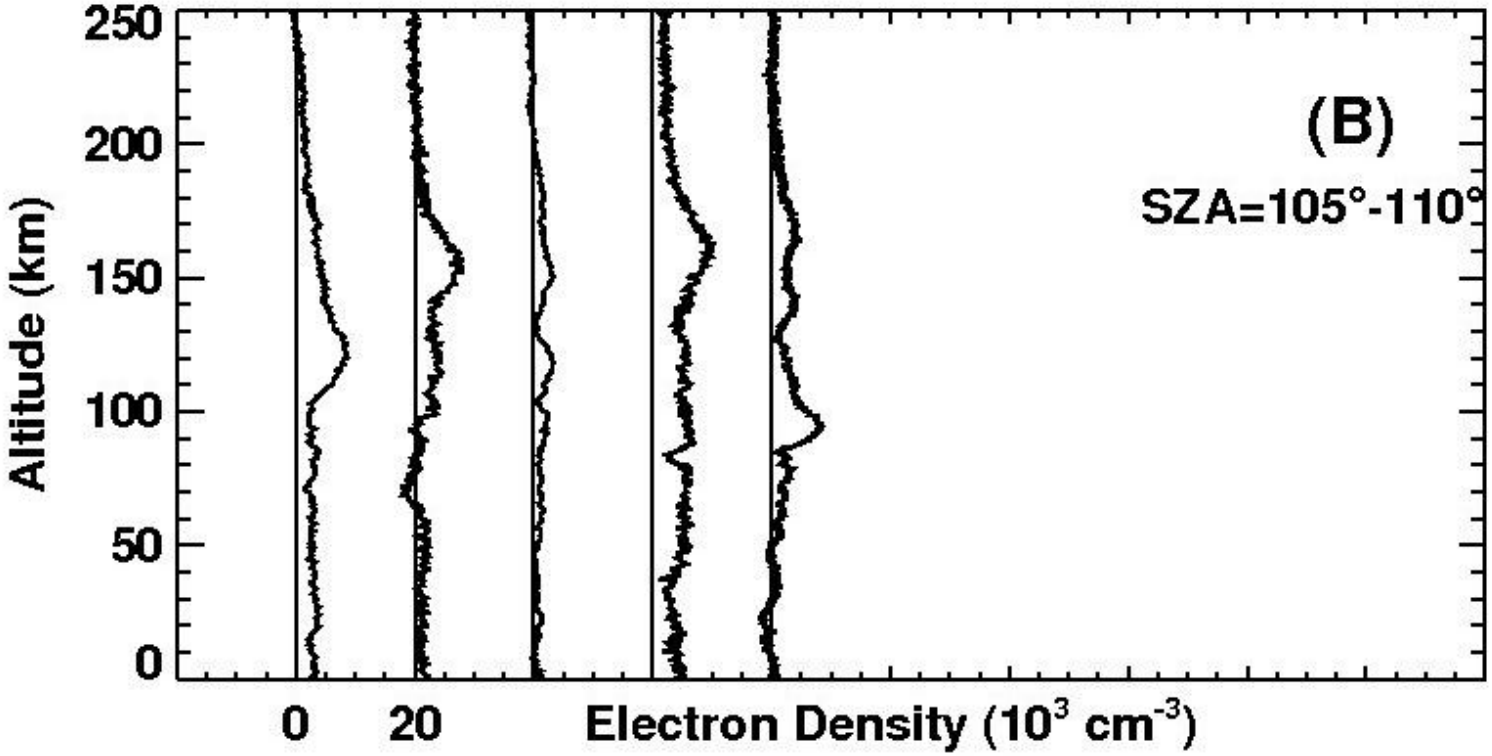
The fine print – 37 MEX differential Doppler profiles from 18 August to 01 October 2005

SZA = 101° to 123° RMS uncertainty is 700 cm^{-3}, which is excellent

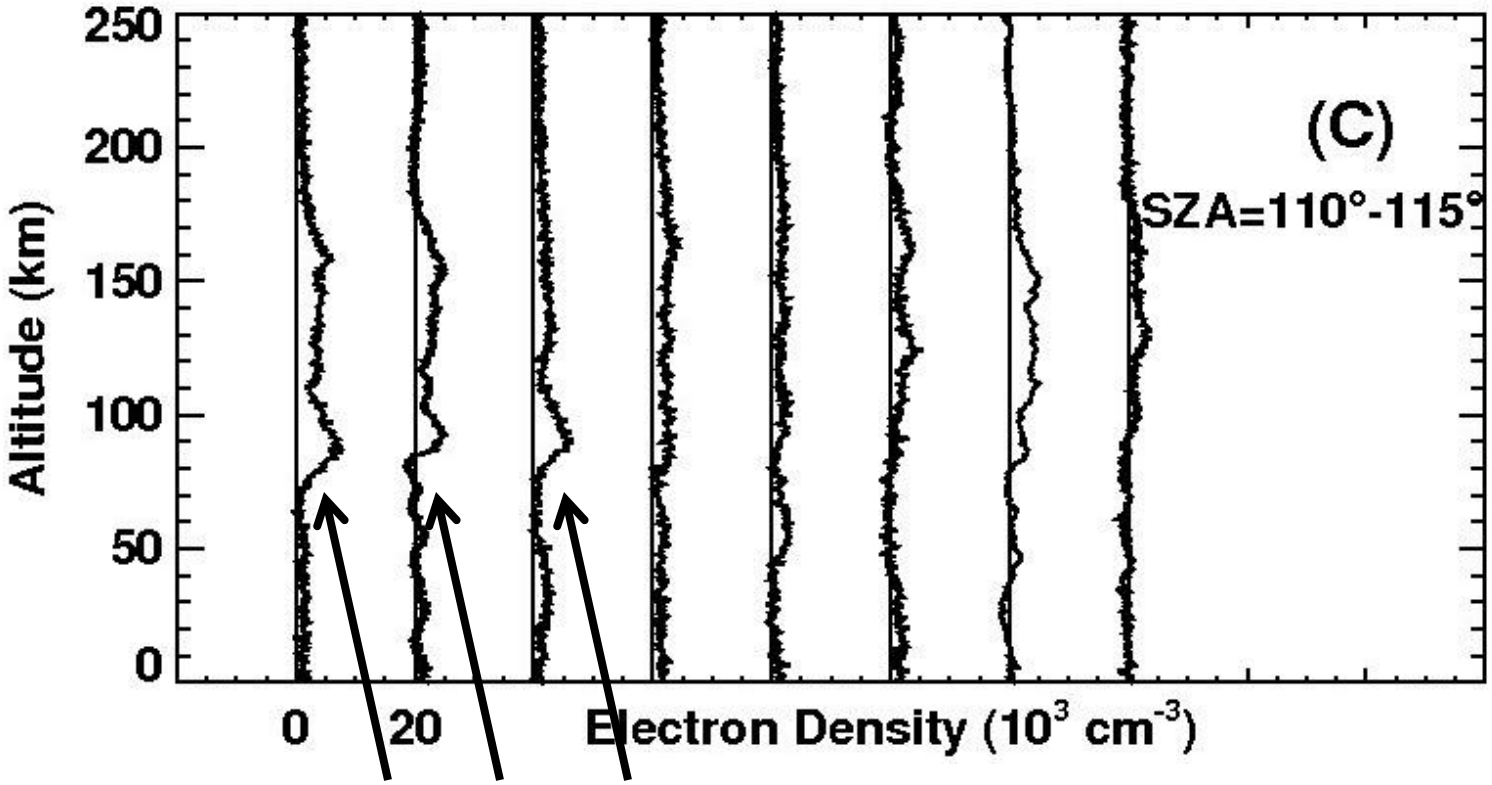
Don't pay attention below 70 km, assumptions of differential Doppler technique fail

All profiles poleward of 38°N, so no crustal magnetic field effects

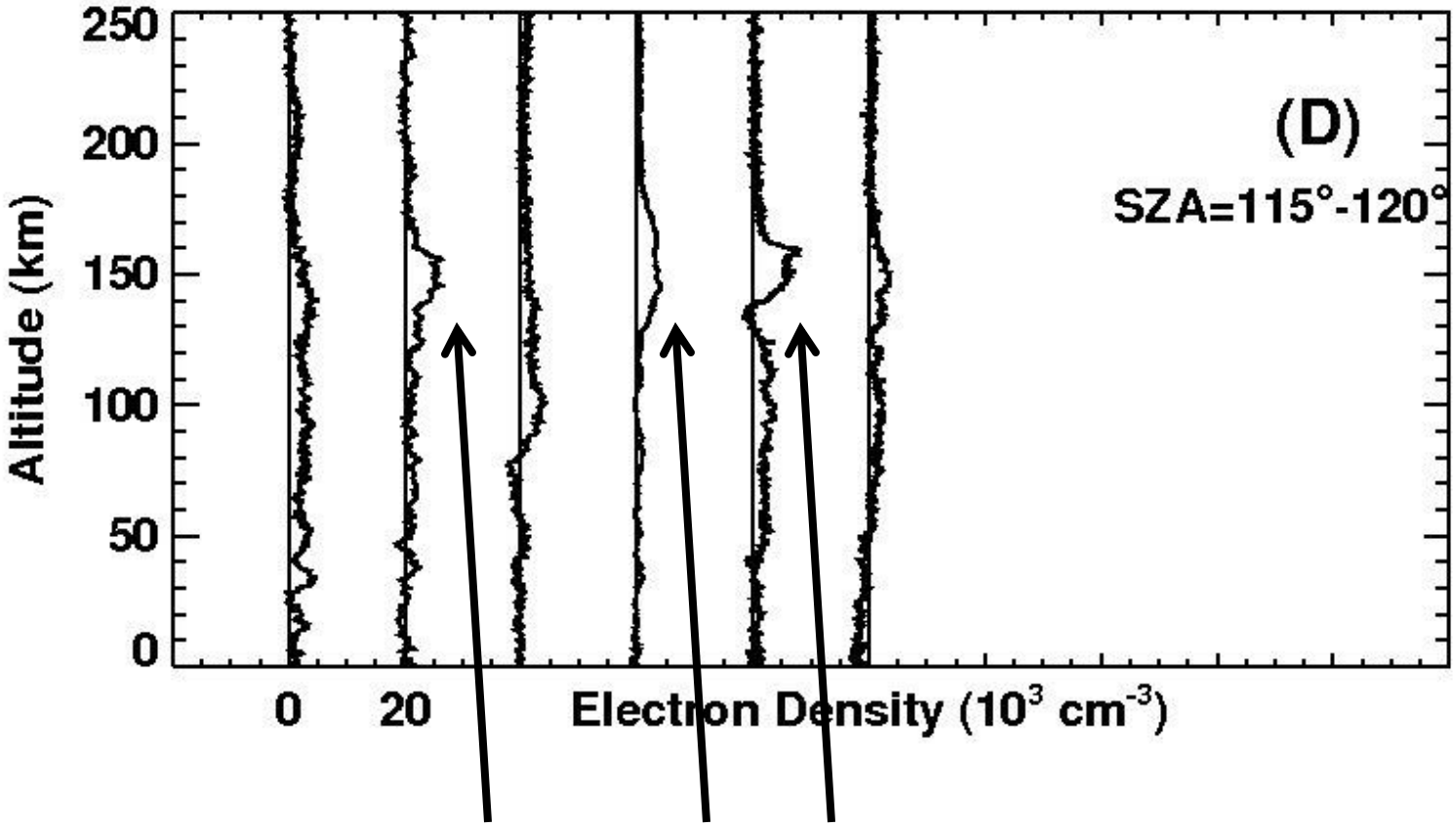
Entering the night..



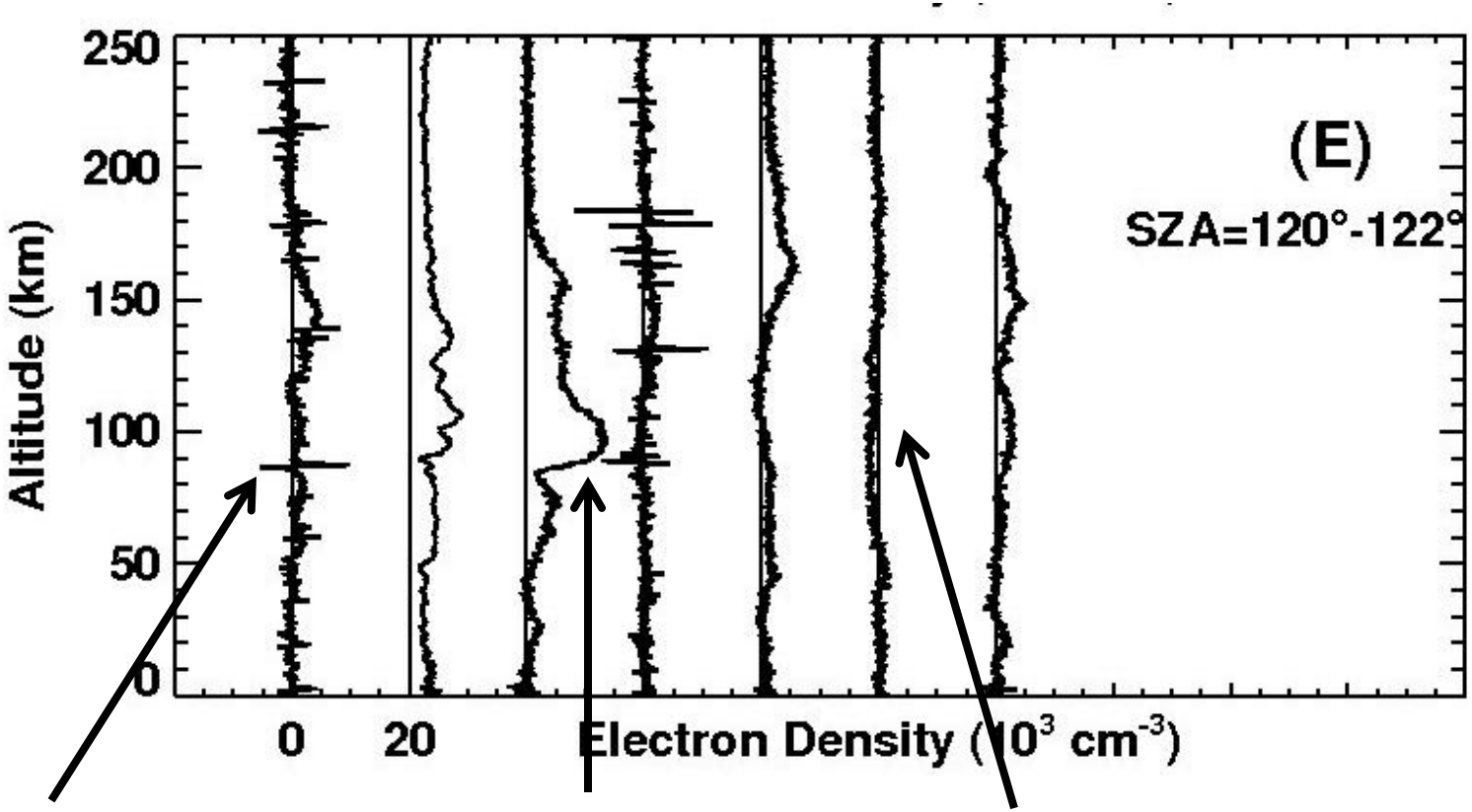
Peak densities decrease and profile shapes become variable



Several profiles from 27-28 August 2005
have large peak densities at 90 km
(Solar Energetic Particle event)



Plasma layers at 150 km
due to electron precipitation

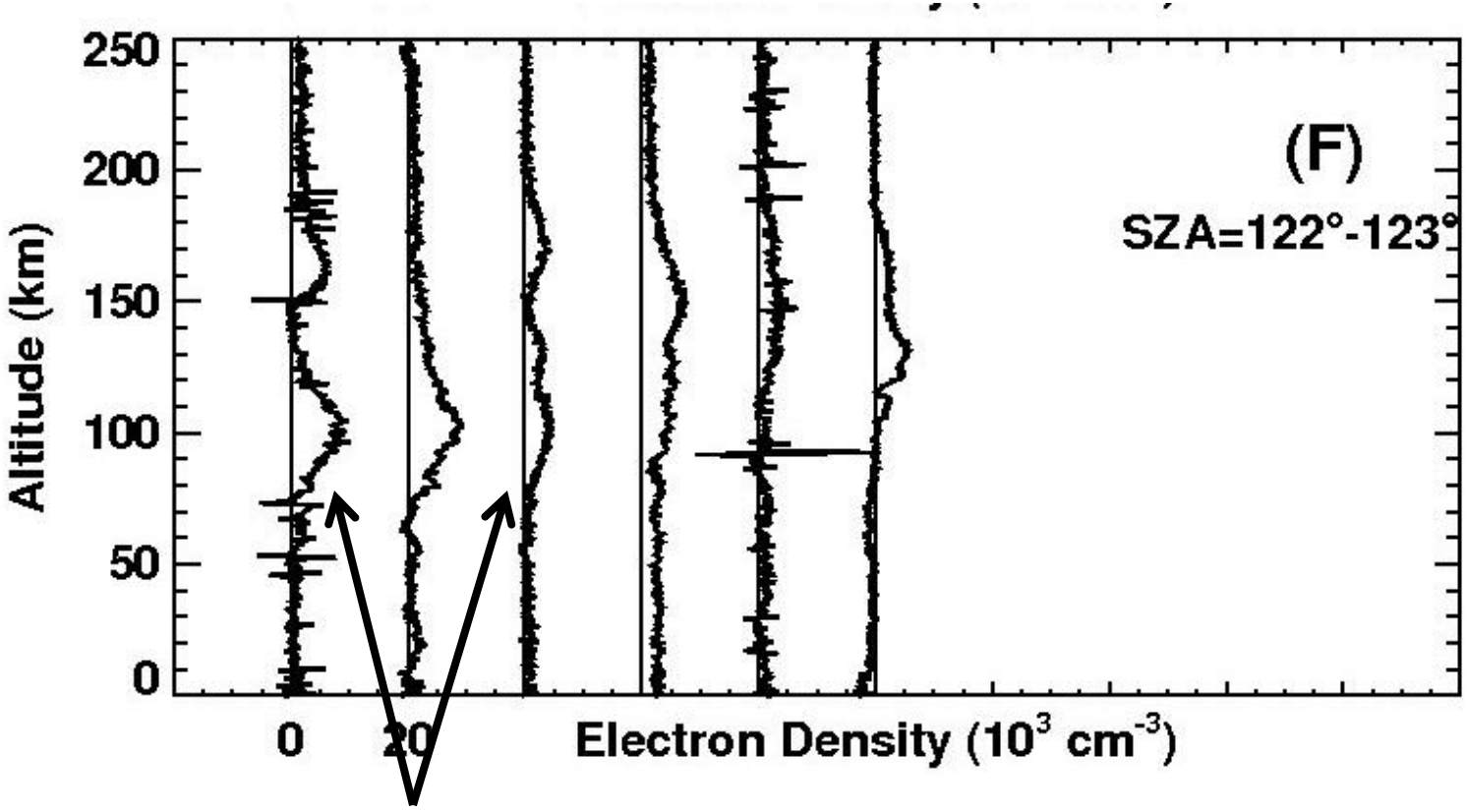


Spikes are cycle slips in the receiver, spurious

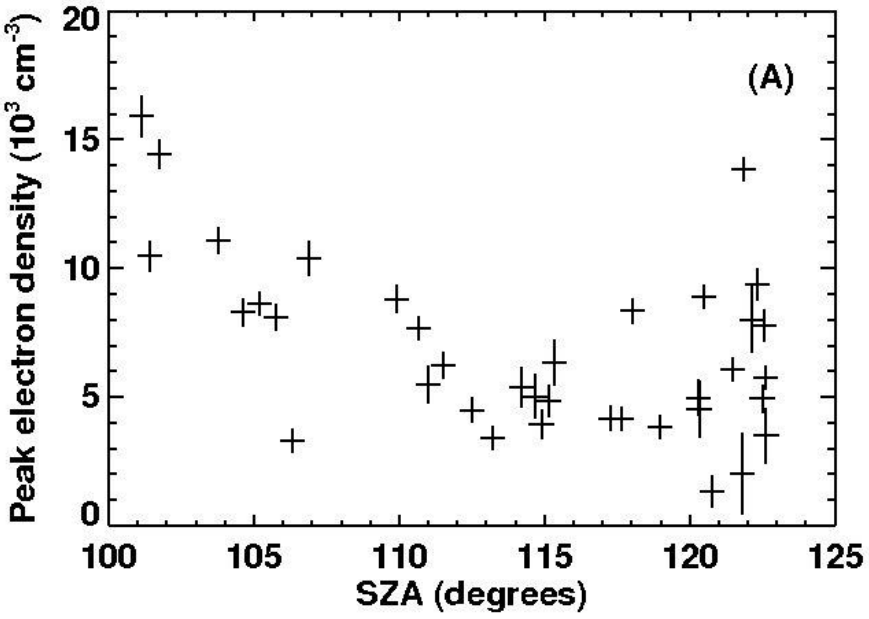
Large peak plasma density (13.9+/-0.5) x 10^3 cm^{-3}

Small peak plasma density (1.3+/-0.6) x 10^3 cm^{-3}

At the largest solar zenith angles



Plasma layers at
100 km and 160 km

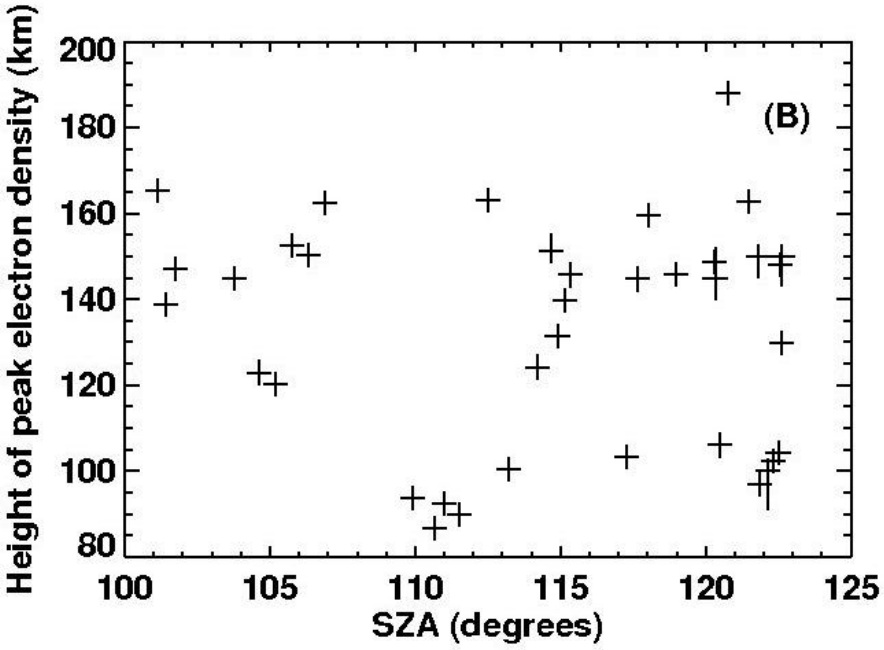


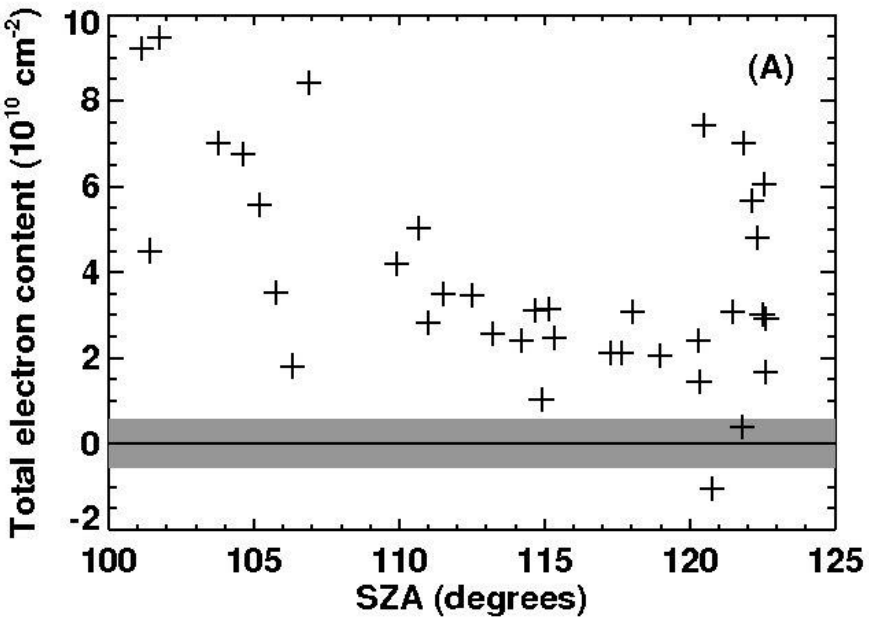
Peak electron density decreases with increasing SZA to 115^o

Presumably transport of dayside plasma is important to this solar zenith angle

SZA<108^o, z = 120-170 km
SZA>108^o, either z<110 km
or z=130-170 km

Transport of dayside plasma
Electron precipitation
Solar energetic particle events
Meteoric plasma layers



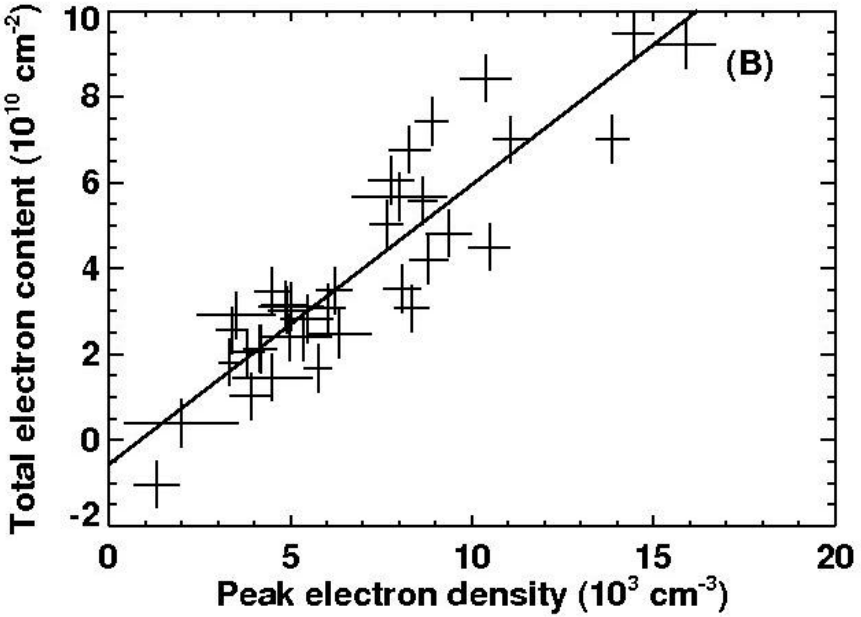


Total electron content (TEC) from 70 km to 250 km
Influenced by solar zenith angle

Values consistent with MARSIS data
Consistent with model predictions

Total electron content =
Peak electron density x 65 km

Unexpected correlation given the wide range of shapes of N(z) profiles



Conclusions

- 37 excellent nightside profiles at SZA=101^{o}-123^{o}
- Wide range of morphologies present
- Cases of small and large peak densities
- Layers attributed to electron precipitation, solar energetic particle events, perhaps more
- Total electron content proportional to peak density

Withers et al. (2012) JGR-A, just published