How does the Magnetic Field of Mars affect the Ionosphere?

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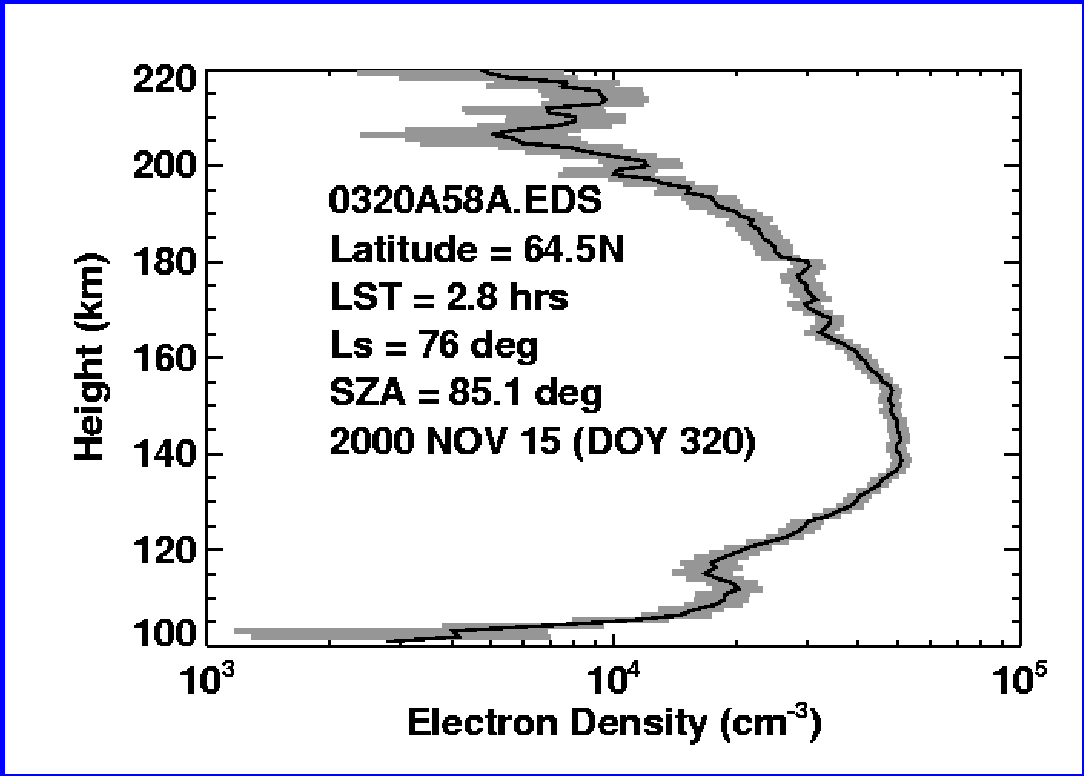
Introduction to Martian Ionosphere and MGS RS Data

MGS RS Data Coverage

60-85N, 60-70S
2-9, 12 hrs LST
70-180 deg Ls – over 2 yrs
70-87 deg SZA
Dec 98, Mar 99, May 99,
and Nov 00 – Jun 01

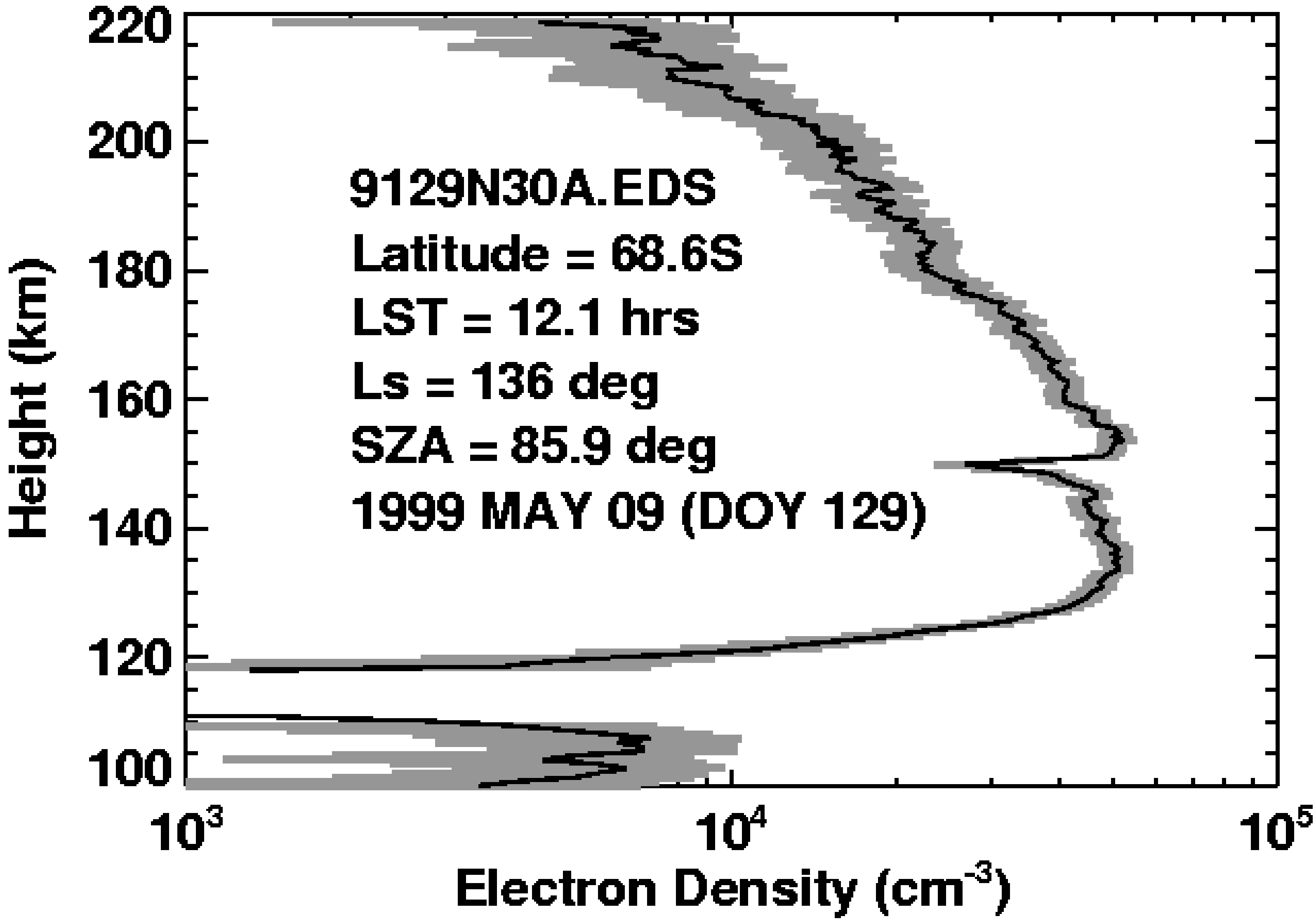


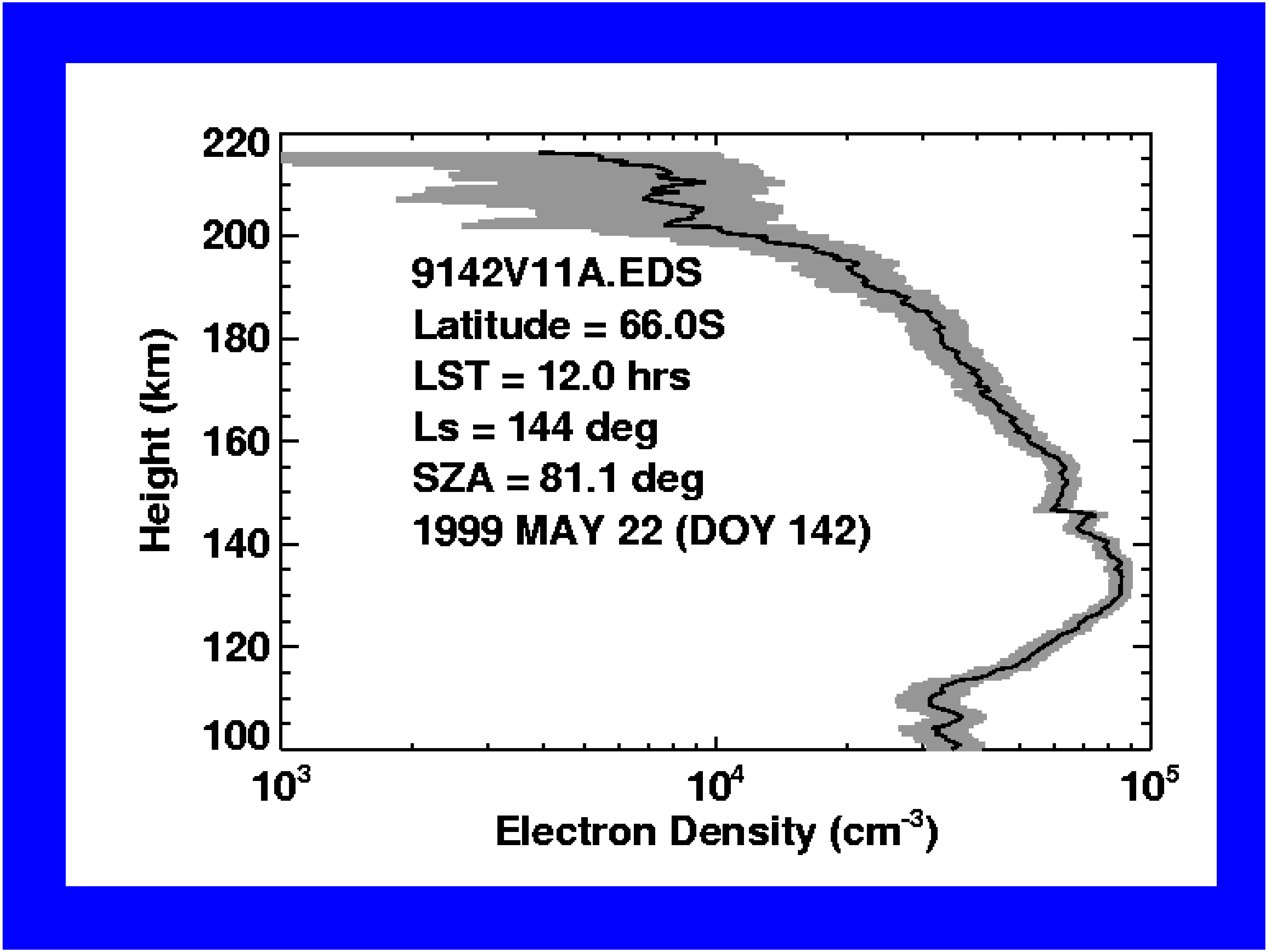
Simplified chemistry

$CO_2 + h\nu \rightarrow CO_2^+ + e$ (fast)
$CO_2^+ + O \rightarrow O_2^+ + CO$ (fast)
$O_2^+ + e \rightarrow O + O$ (slow)

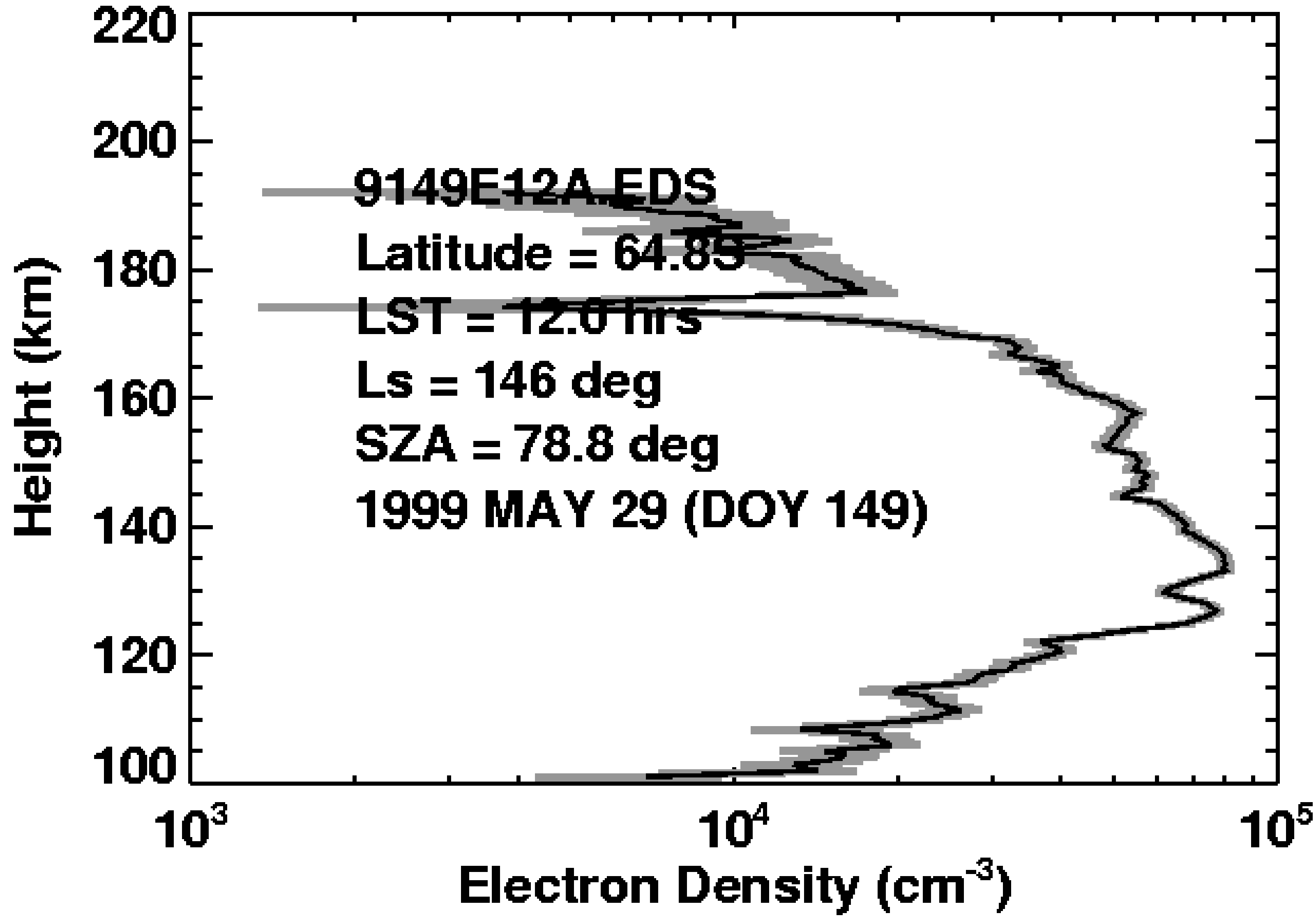
Typical Profile

Primary peak, well fit by alpha-Chapman function, 130-150 km, (4-14) x 1E4 cm^{-3}
Secondary feature (ledge, peak, etc) of variable significance, 110-120 km
Primary peak mainly from 30.38 nm (Helium) flux, secondary peak from few nm X-rays
Wavy topside with H decreasing as altitude increases

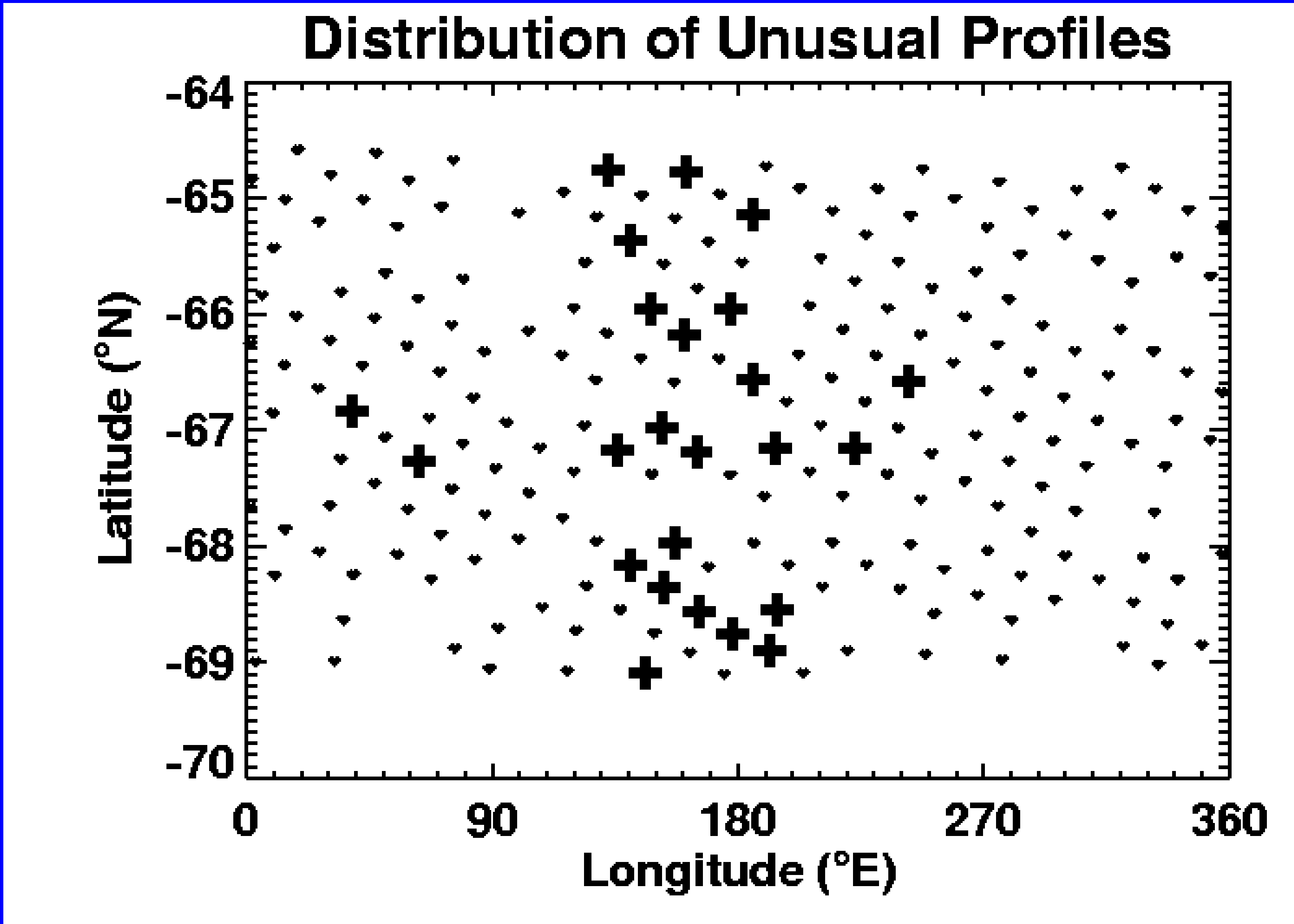

9129N30A.EDS
Latitude = 68.6S
LST = 12.1 hrs
Ls = 136 deg
SZA = 85.9 deg
1999 MAY 09 (DOY 129)
Height (km)
220
200
180
160
140
120
100
10^3
10^4
10^5
Electron Density (cm^{-3})



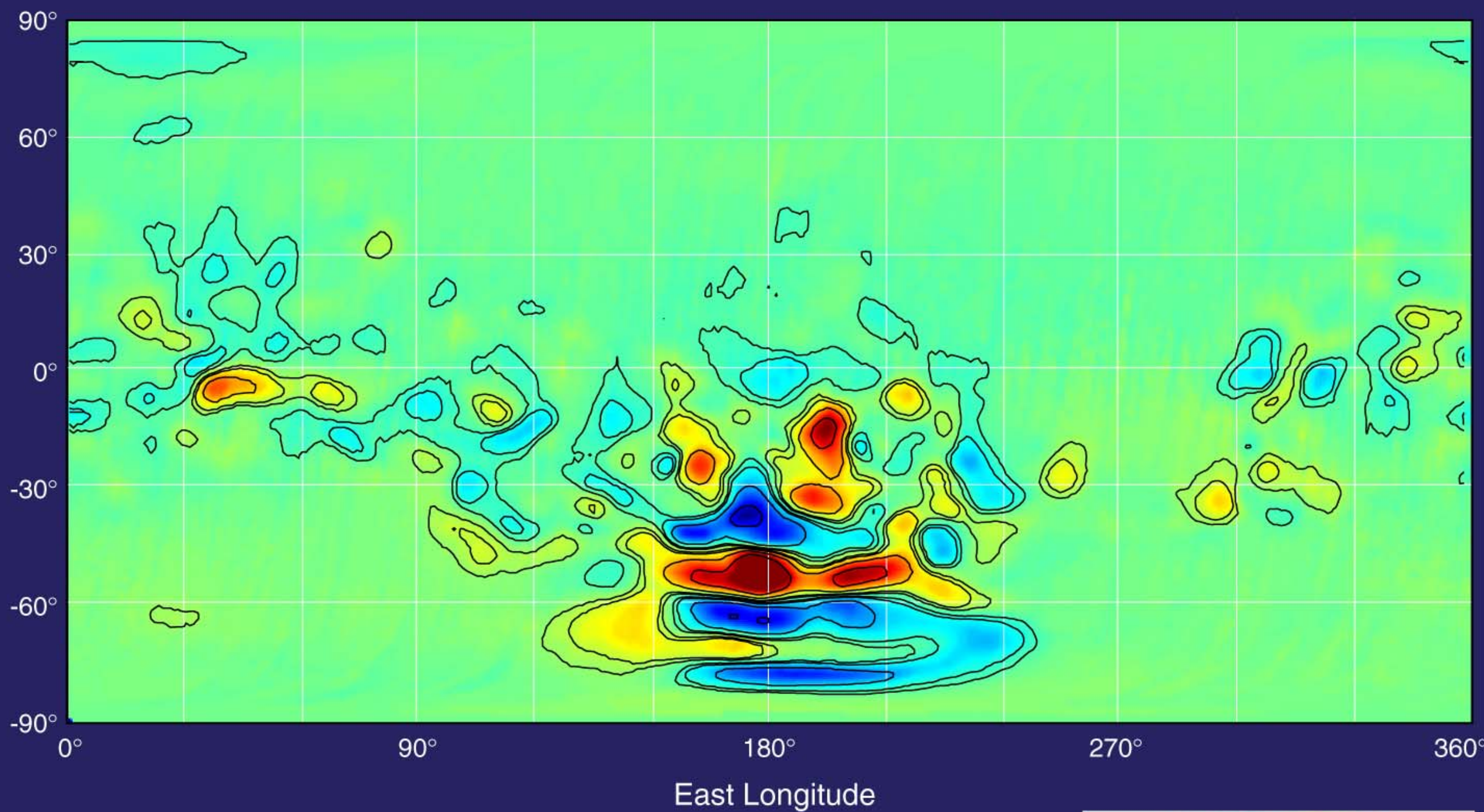
220
200
180
160
140
120
100
Height (km)
9142V11A.EDS
Latitude = 66.0S
LST = 12.0 hrs
Ls = 144 deg
SZA = 81.1 deg
1999 MAY 22 (DOY 142)
10^3
10^4
10^5
Electron Density (cm^{-3})

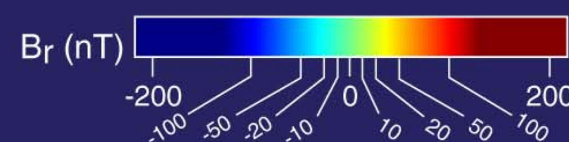


9149E12A.EDS
Latitude = 64.8S
LST = 12.0 hrs
Ls = 146 deg
SZA = 78.8 deg
1999 MAY 29 (DOY 149)
Height (km)
220
200
180
160
140
120
100
10^3
10^4
10^5
Electron Density (cm^{-3})


Distribution of Unusual Profiles
Latitude (°N)
-64
-65
-66
-67
-68
-69
-70
0
90
180
270
360
Longitude (°E)

Mars Crustal Magnetism **Mars Global Surveyor** **MAG/ER**





Br at 400 km altitude, max value ~ 200 nT

Connerney et al., *Geophys.Res. Lett.*, *28*, 4015-4018, 2001.

ConJ2001187.001v

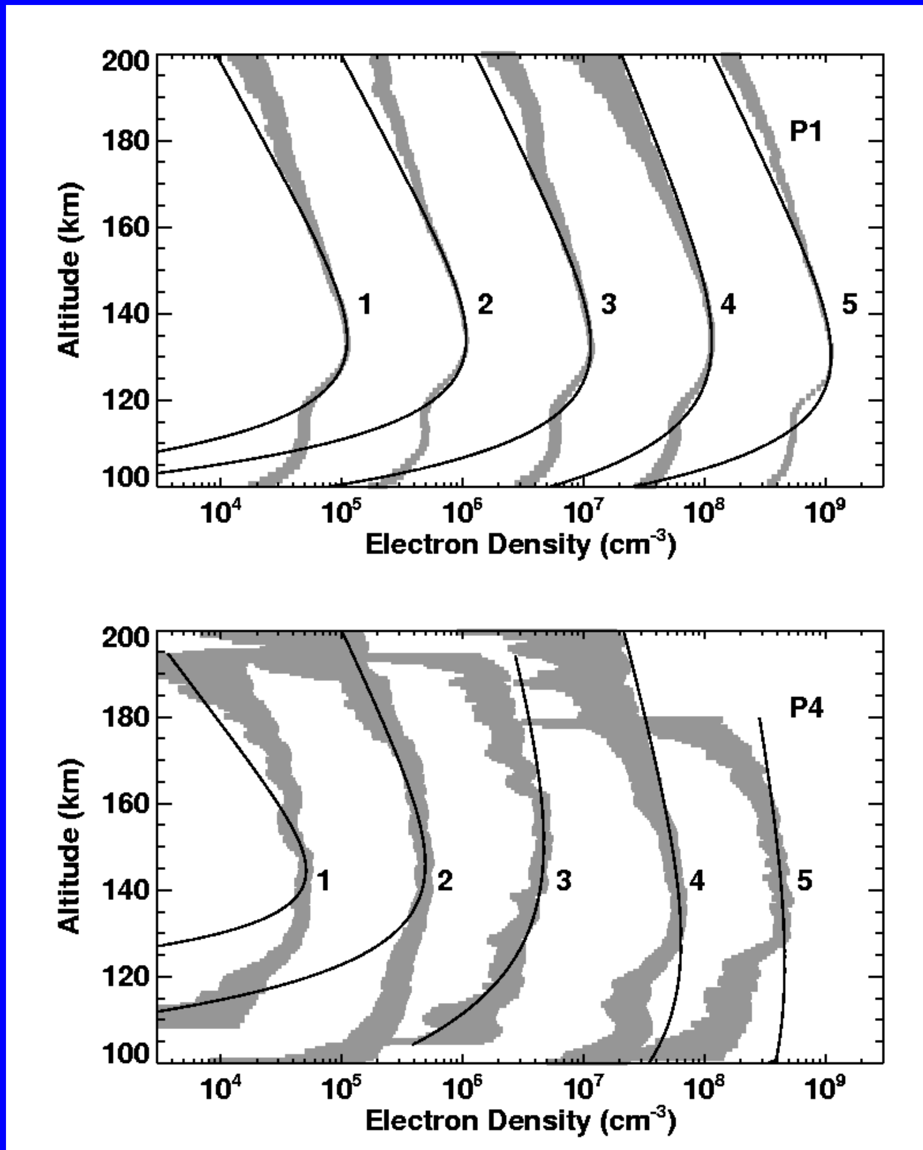
Effects of B on an Ionosphere

- Modify influx of energetic particles
- Modify ion/electron diffusion
- Modify ion/electron transport by winds

$$N_i m_i \nu_{in} \left(\underline{v_i} - \underline{u} \right) = N_i e \left(\underline{E} + \underline{v_i} \times \underline{B} \right) - k \underline{\nabla} \left(N_i T_i \right) + N_i m_i \underline{g}$$

$$N_e m_e \nu_{en} \left(\underline{v_e} - \underline{u} \right) = -N_e e \left(\underline{E} + \underline{v_e} \times \underline{B} \right) - k \underline{\nabla} \left(N_e T_e \right) + N_e m_e \underline{g}$$

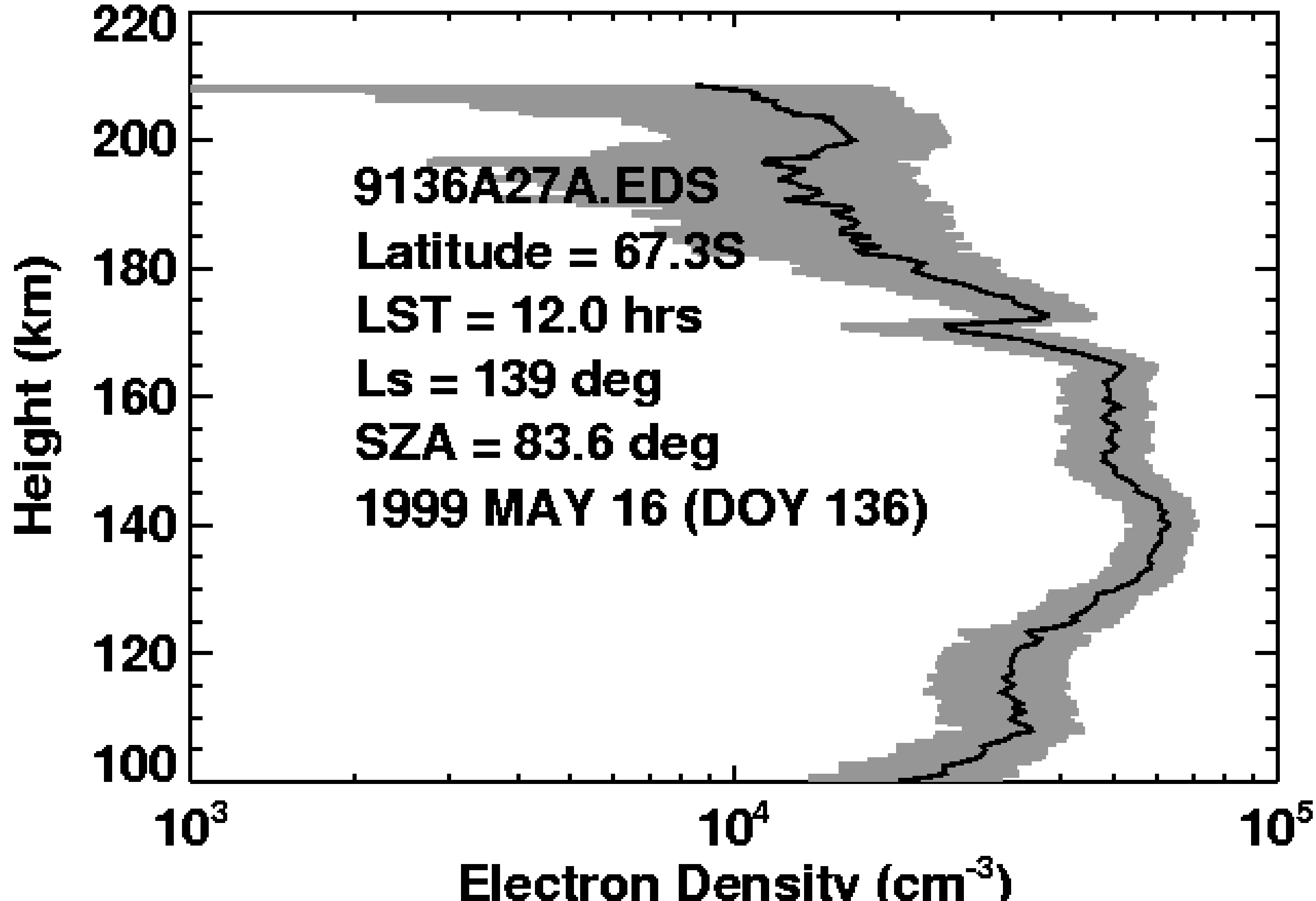
- plus Maxwell and Continuity …
- u, B known, E unknown, want vi, ve when B is weak, moderate, and strong…suggestions welcome
- Textbooks always know E or have B weak/strong
- **Question: What do you think is going on?**

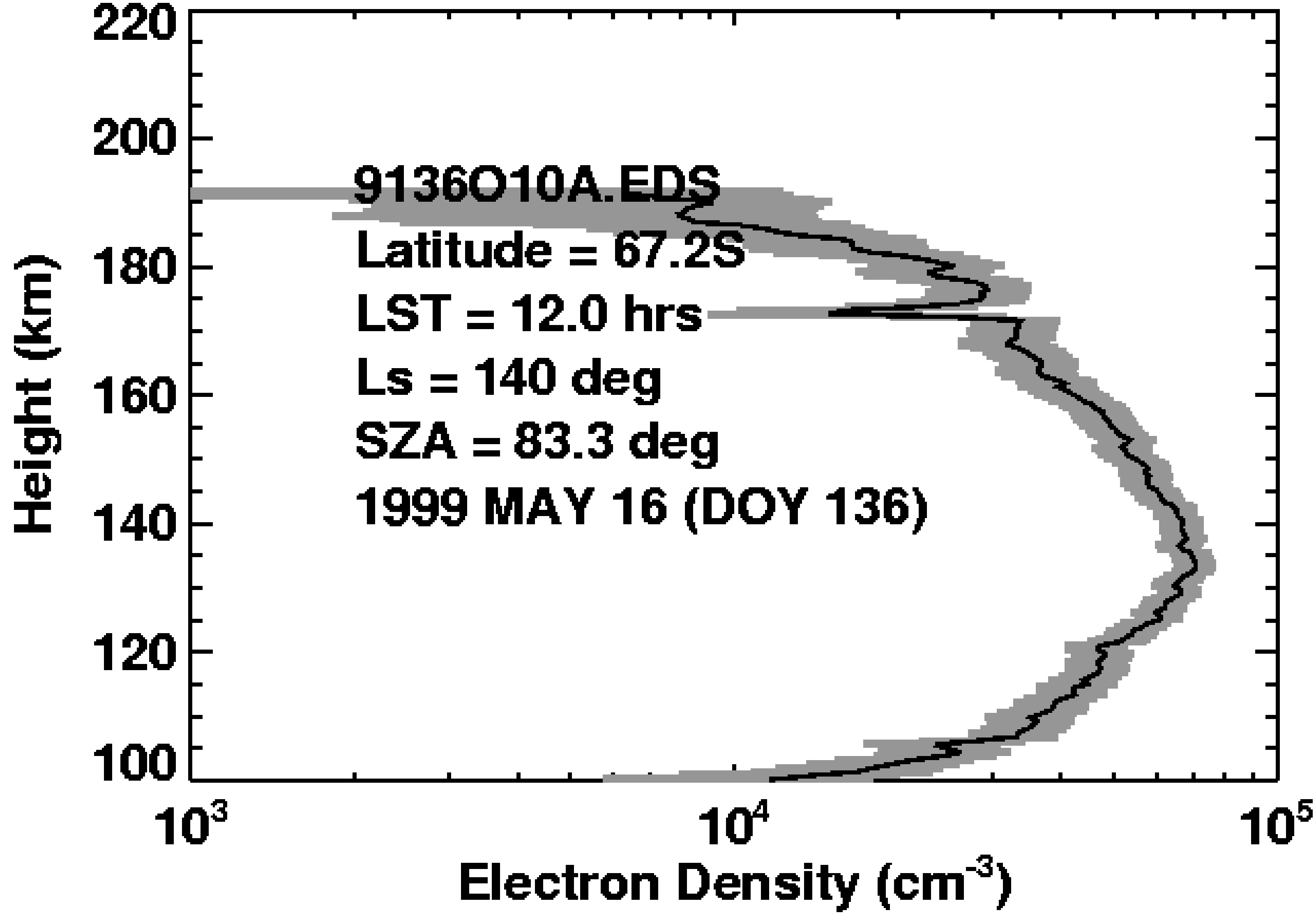


NH examples, Chapman fit is good

SH examples, Chapman fit is not good
65S, 12 noon, 80 SZA, strong winds close to boundary of winter polar night

What are dynamics doing?


9136A27A.EDS
Latitude = 67.3S
LST = 12.0 hrs
Ls = 139 deg
SZA = 83.6 deg
1999 MAY 16 (DOY 136)
Height (km)
220
200
180
160
140
120
100
10^3
10^4
10^5
Electron Density (cm^{-3})


9136O10A.EDS
Latitude = 67.2S
LST = 12.0 hrs
Ls = 140 deg
SZA = 83.3 deg
1999 MAY 16 (DOY 136)
Height (km)
220
200
180
160
140
120
100
10^3
10^4
10^5
Electron Density (cm^{-3})