The Martian Ionosphere in Regions of Crustal Magnetic Fields

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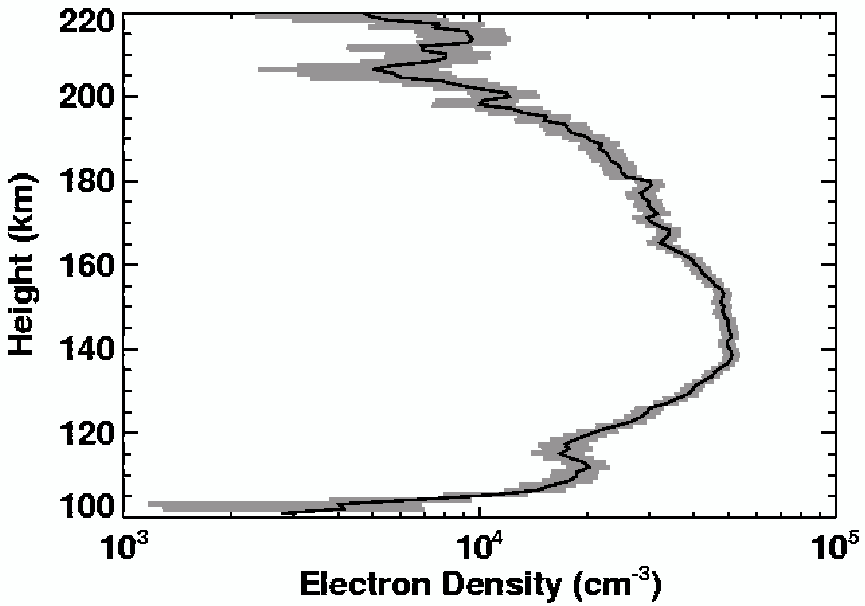
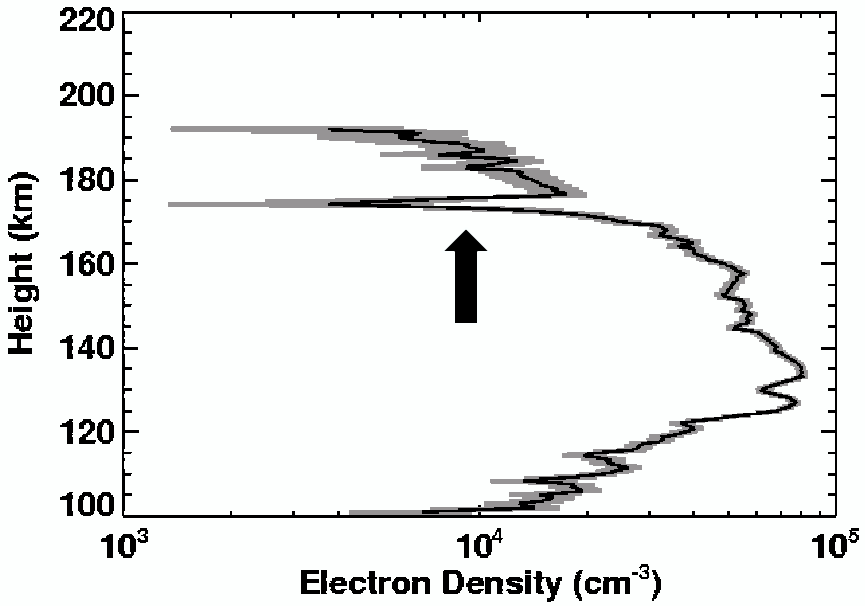
- Abnormal electron density profiles are found over crustal magnetic anomalies in the southern hemisphere
- How does the martian magnetic field affect the ionosphere?

Normal Profile



Abnormal Profile

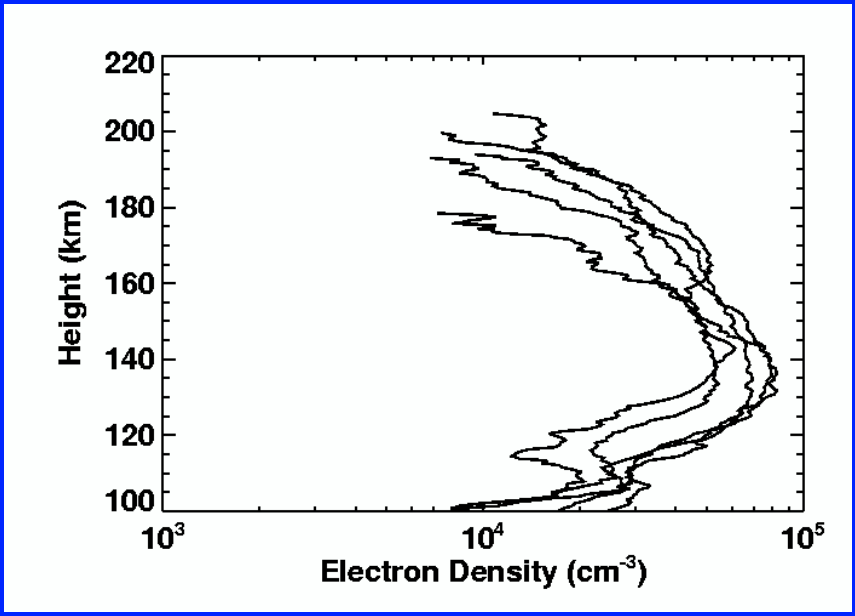


"Abnormal" defined as: $\max | dN_e/dz | / \max (N_e) > 1 / 6$ km

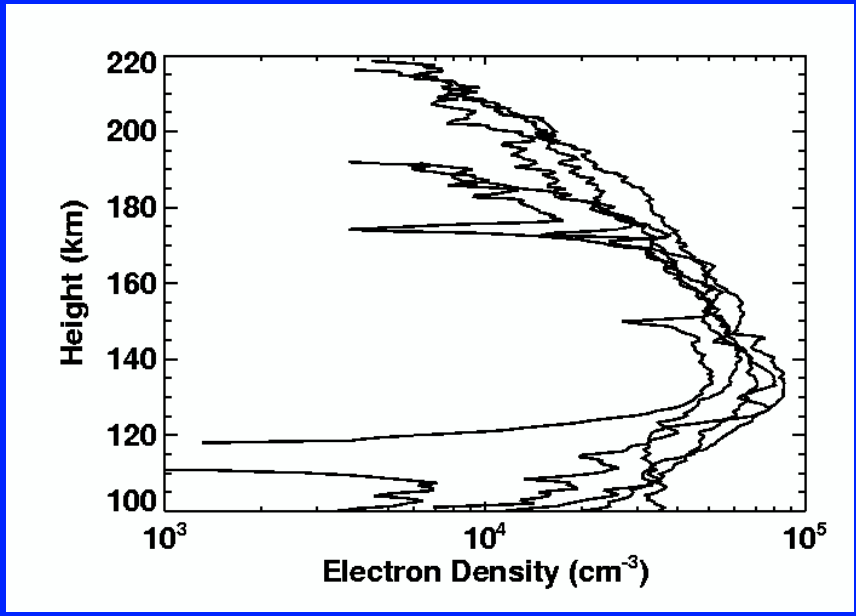
Aim is to identify profiles with large changes in n over a short distance – **extreme waviness**. Exact definition is subjective and will probably be improved.

Horizontal scale of measurement, sqrt(H R), is ~ 200 km

5 Normal Profiles



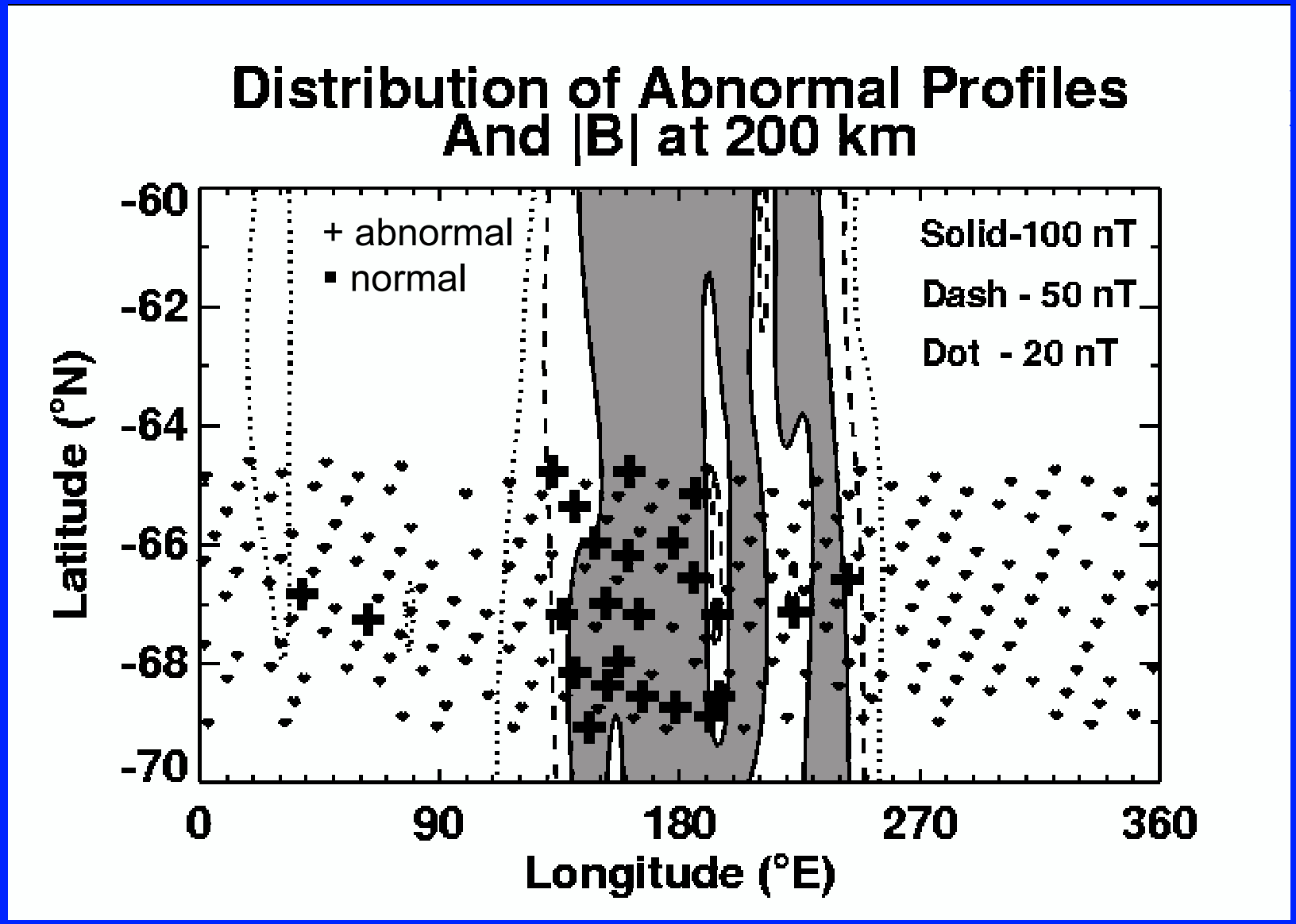
5 Abnormal Profiles



Compare 5 abnormal profiles to 5 normal profiles from same latitude/SZA/time population

Much more variation exists within the abnormal subset

Are abnormal profiles associated with geographic regions?



We thank to Jafar Arkani-Hamed for his magnetic field model

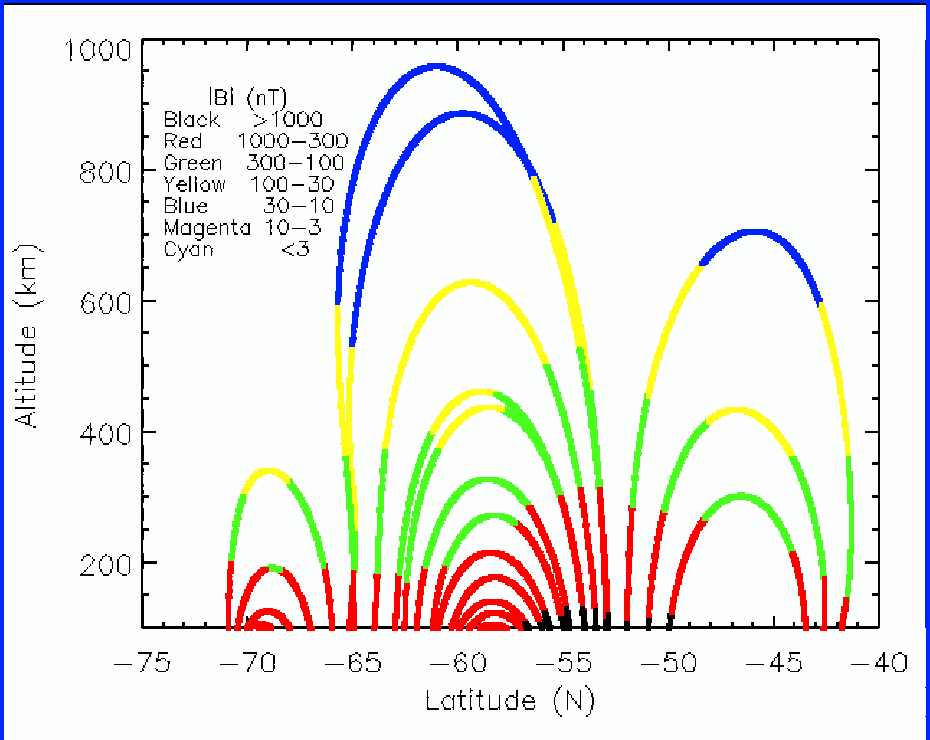
Magnetic Fields Can …

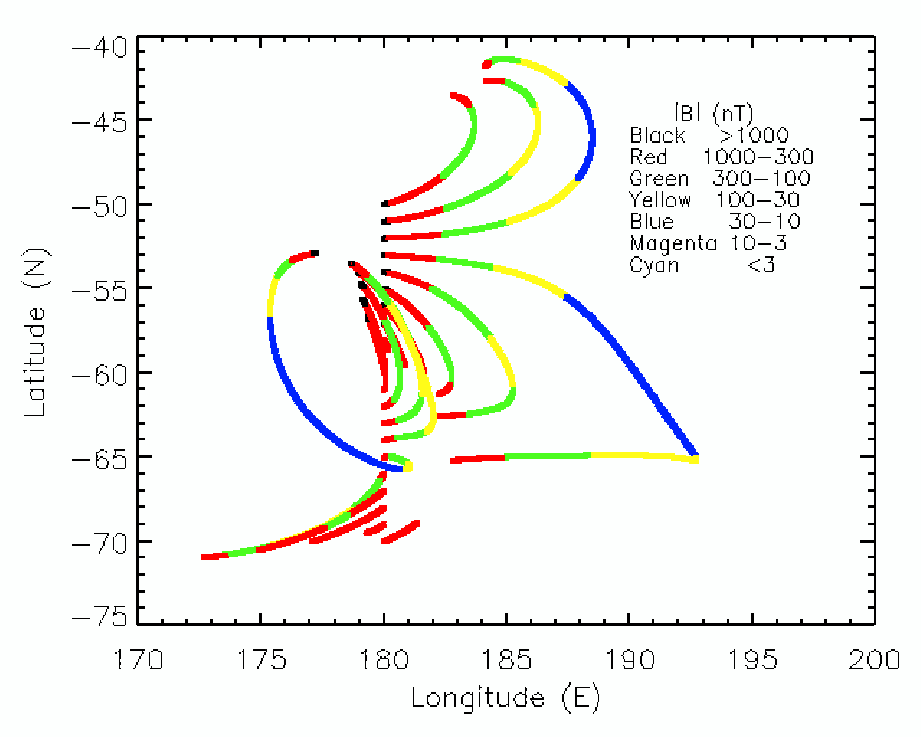
- Modify influx of energetic particles
- Modify plasma diffusion due to gravity, pressure
- Modify plasma transport by winds

- Relative size of ion-neutral collision frequency and ion gyrofrequency is critical – $eB/m_i\nu_{in}$
- What happens when $eB/m\nu_{in}$ is ~ 1?

- We are developing models to simulate these interactions

Some Fieldlines





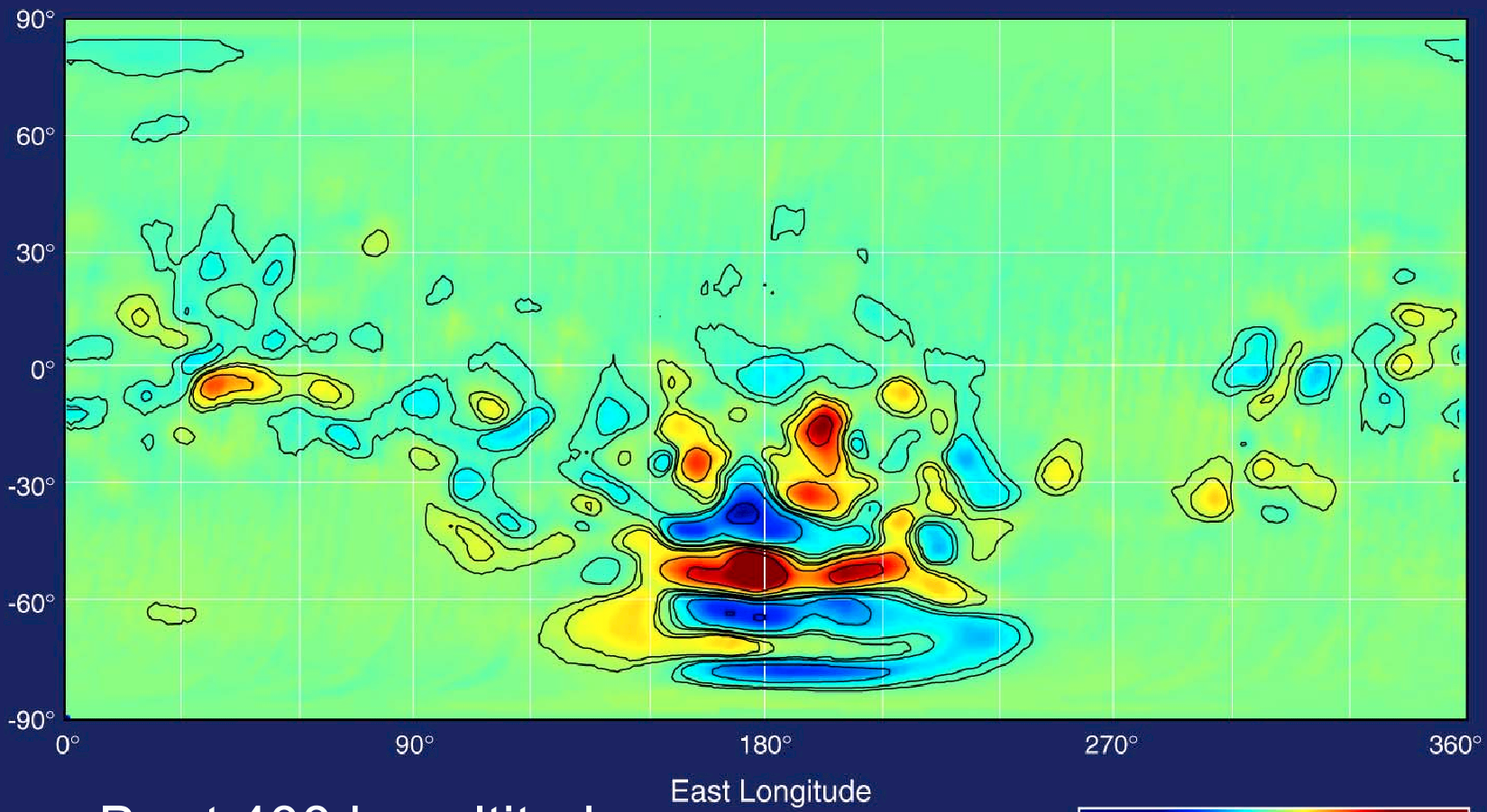
- Regions of vertical fieldlines
- Regions of horizontal fieldlines
- Note that solar wind field is neglected
- Geometry changes over short distances

Conclusions

- Some ionospheric profiles over crustal magnetic anomalies are abnormal due to their extreme waviness

- It is important to understand interactions between the ionosphere and magnetic field because
  - The topology of the magnetic field of Mars is unique, having a small characteristic length scale
  - How have interactions between the ionosphere and magnetic field affected the loss of volatiles?
  - Do these interactions affect the energy and momentum balances of the neutral atmosphere?

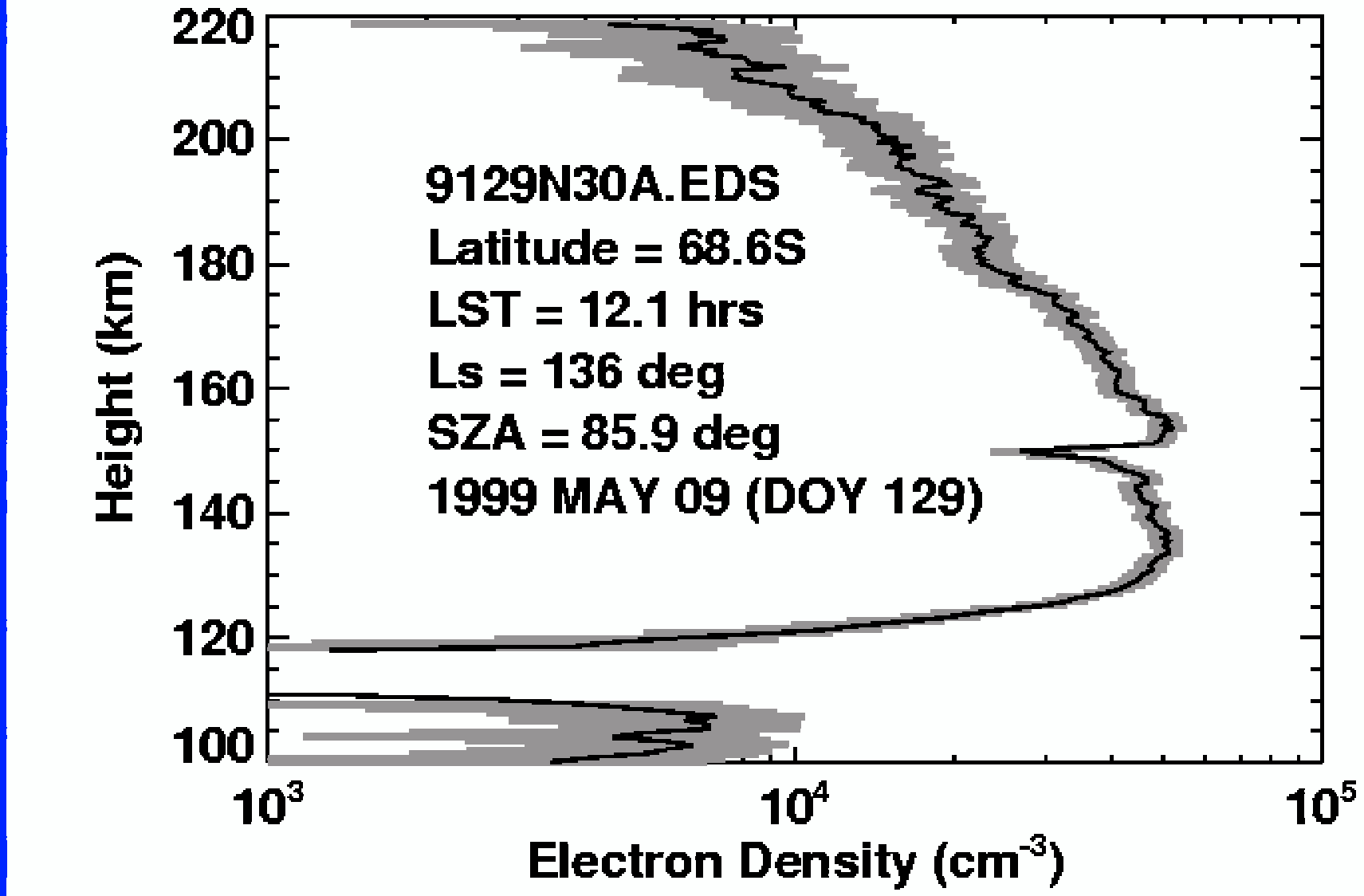
Mars Crustal Magnetism Mars Global Surveyor MAG/ER

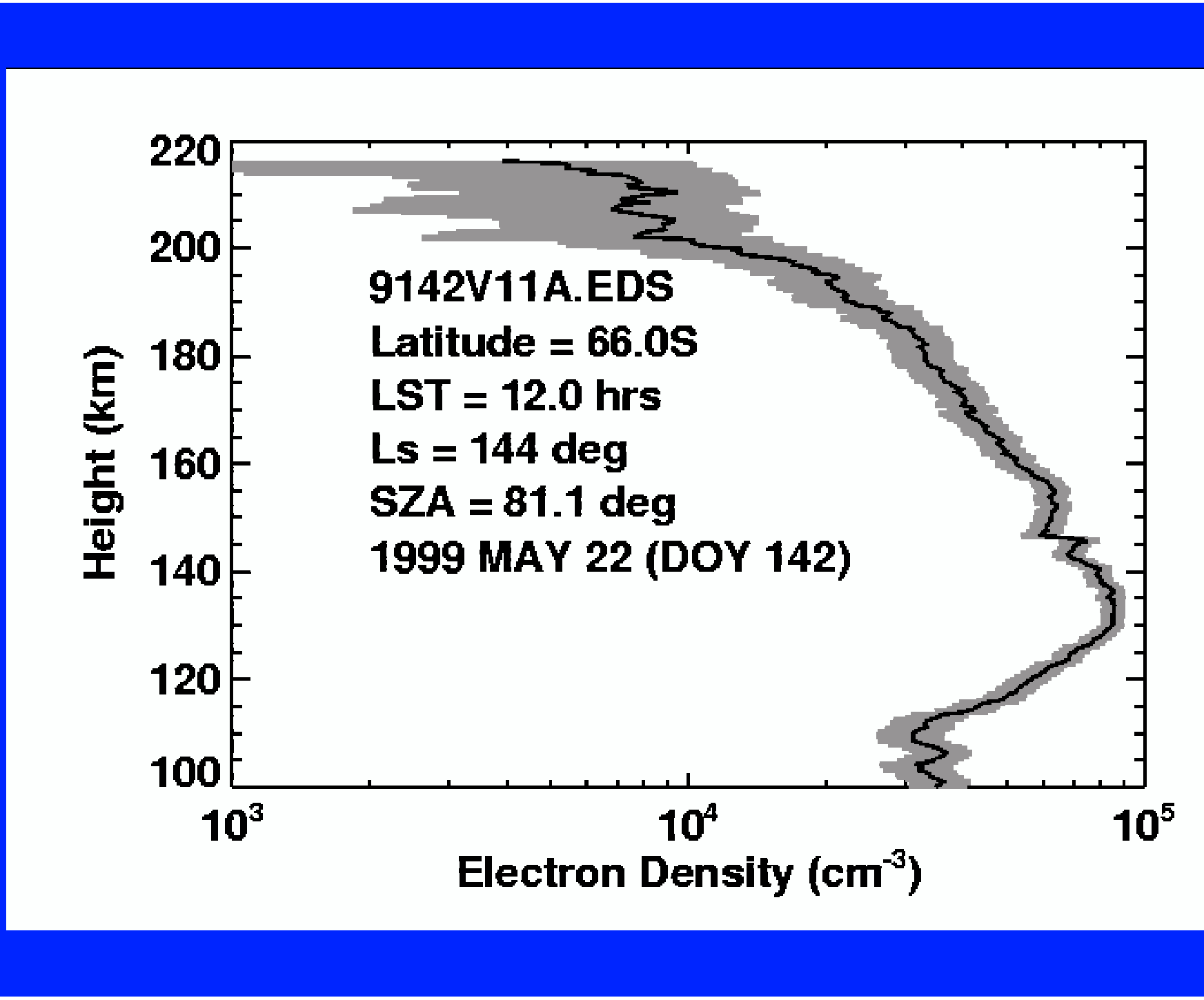


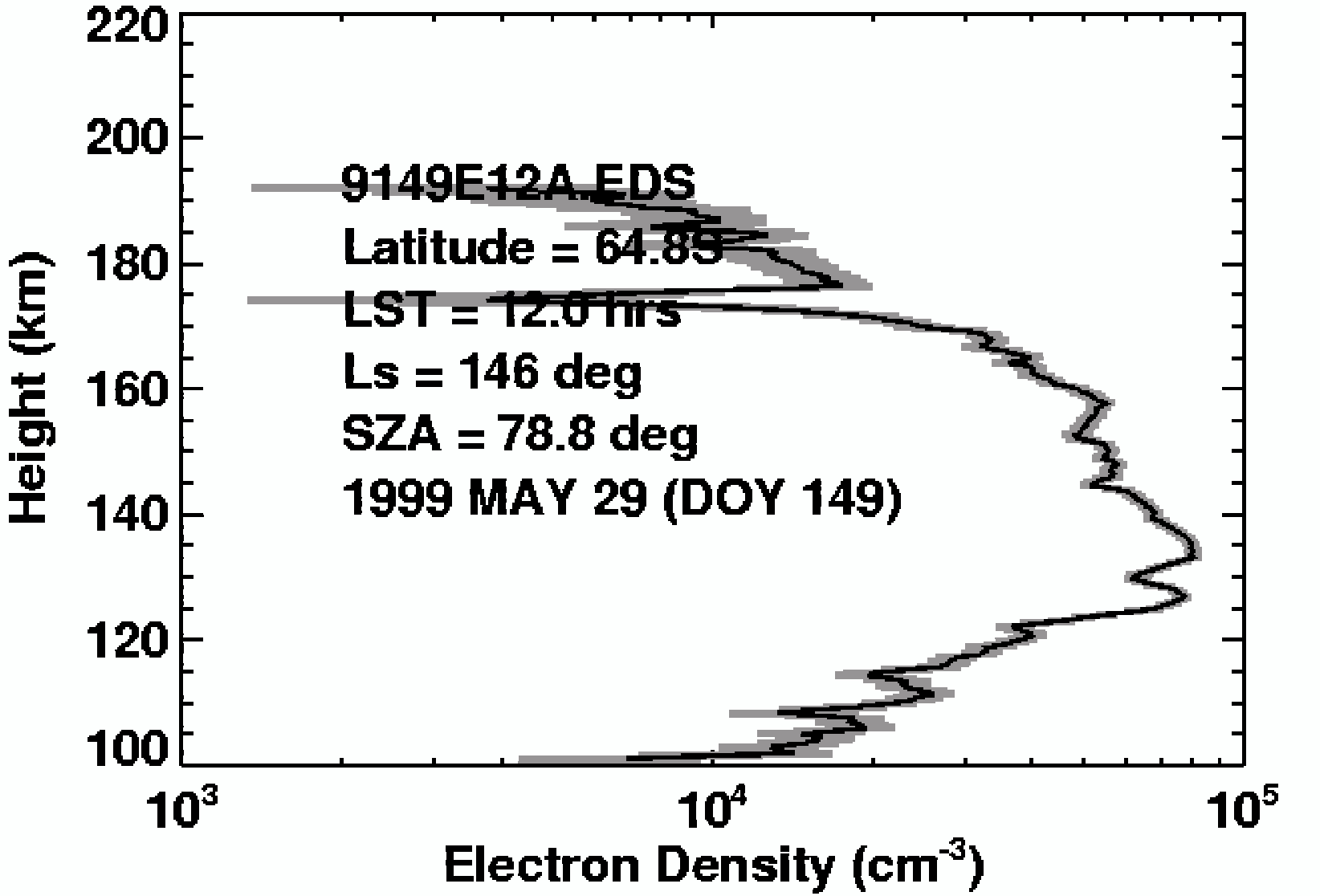
Br at 400 km altitude,
max value ~ 200 nT

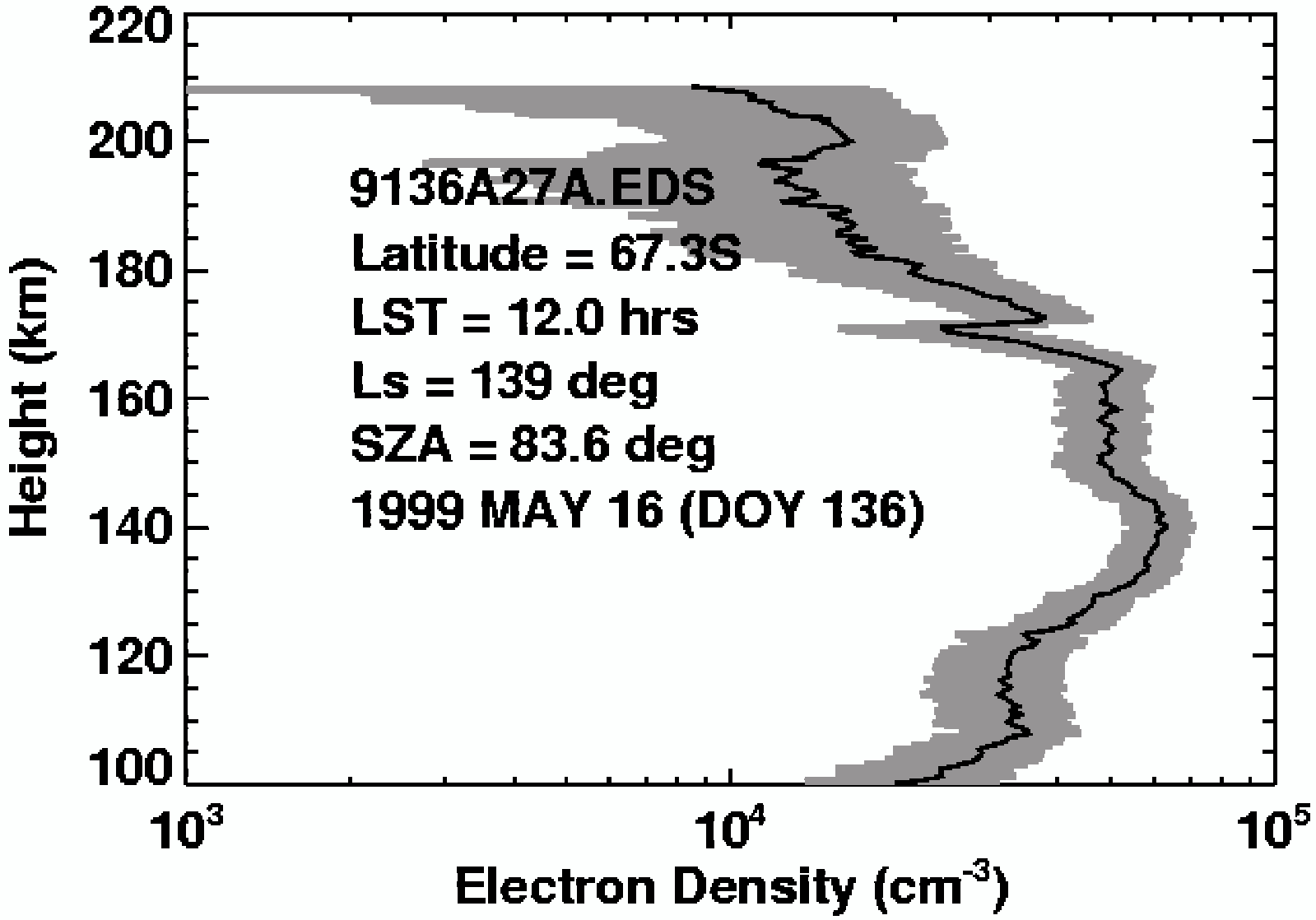
Connerney et al., *Geophys.Res. Lett., 28,* 4015-4018, 2001.

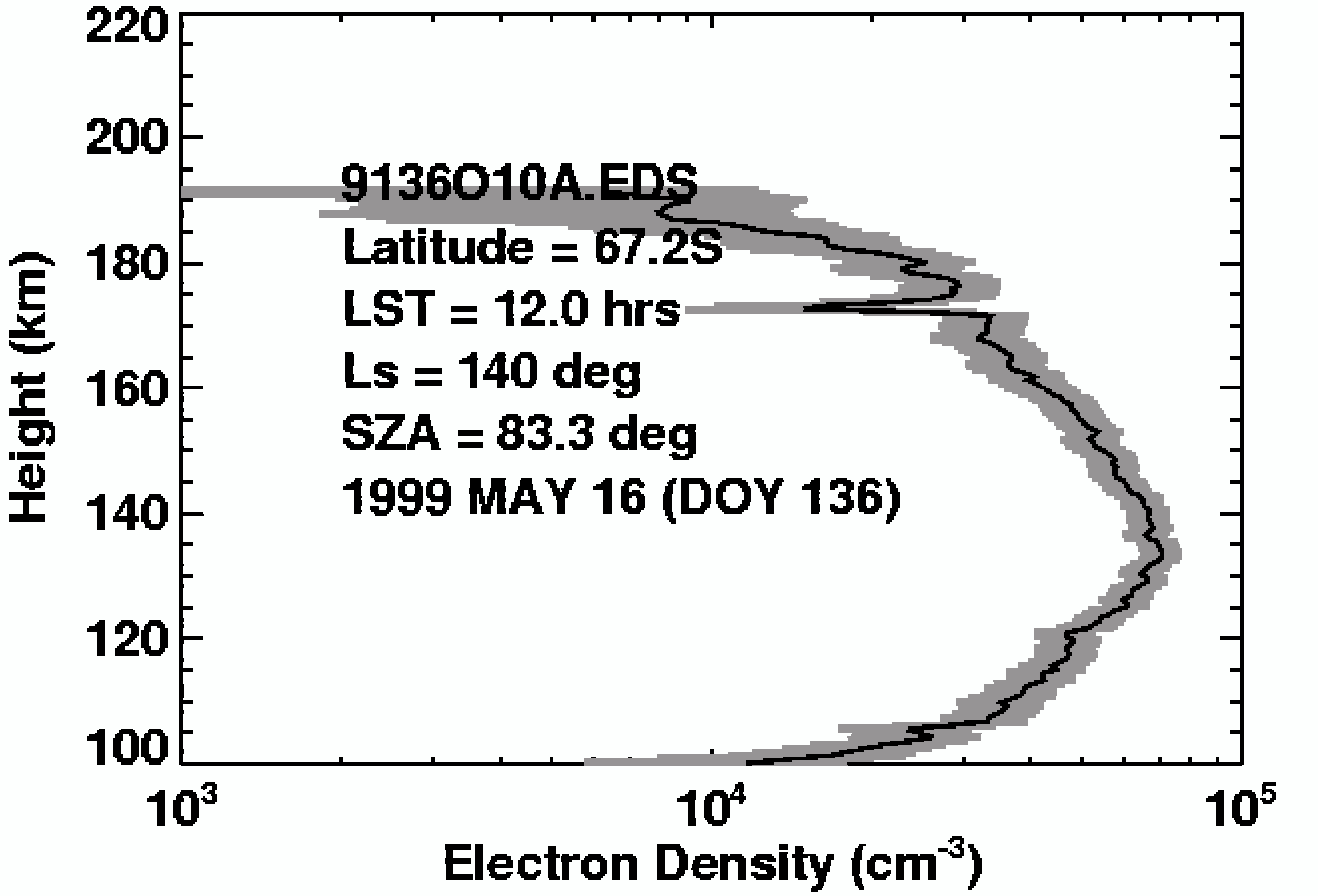
ConJ2001187.001v

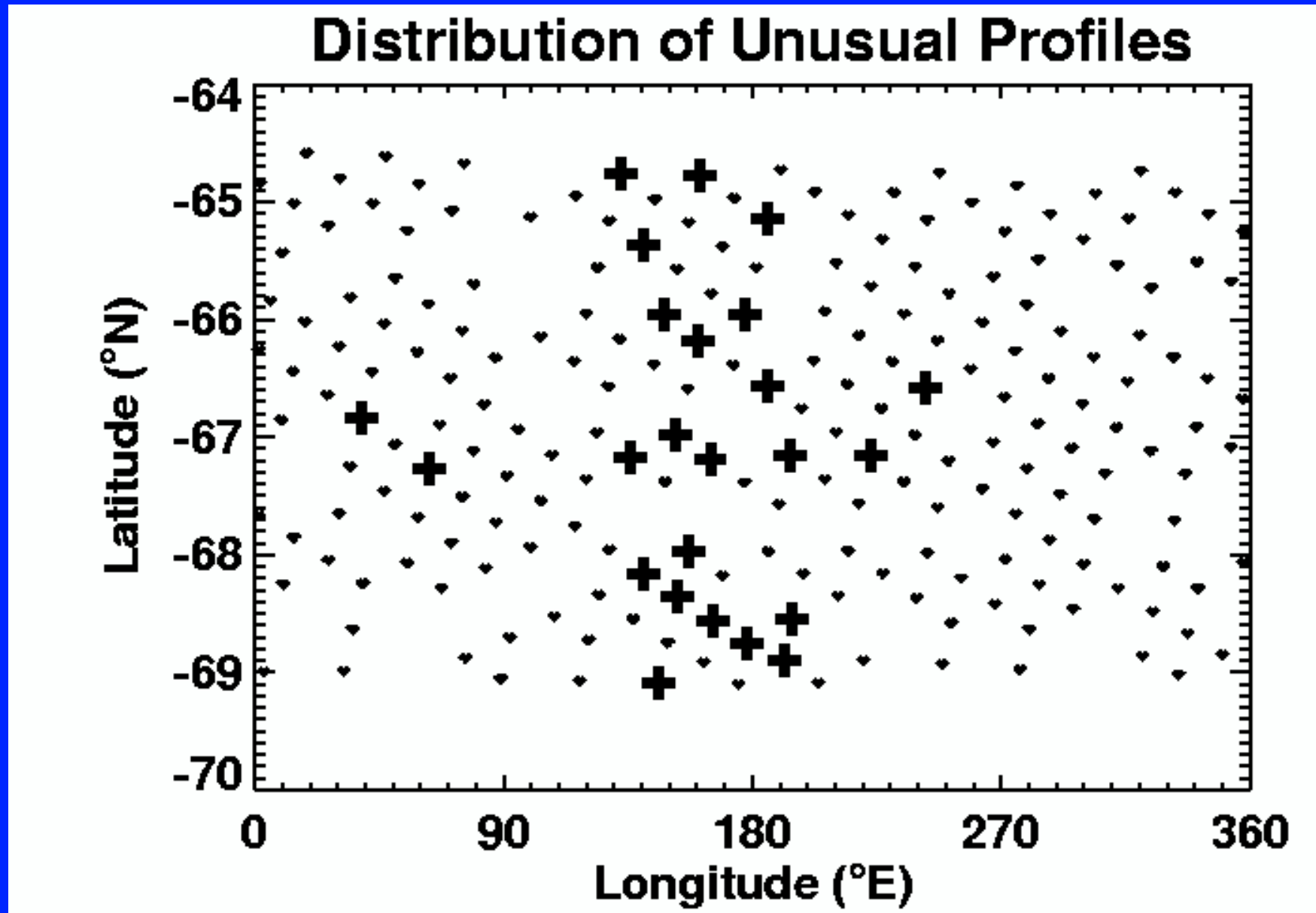

9129N30A.EDS
Latitude = 68.6S
LST = 12.1 hrs
Ls = 136 deg
SZA = 85.9 deg
1999 MAY 09 (DOY 129)
Height (km)
220
200
180
160
140
120
100
10^3
10^4
10^5
Electron Density (cm^{-3})

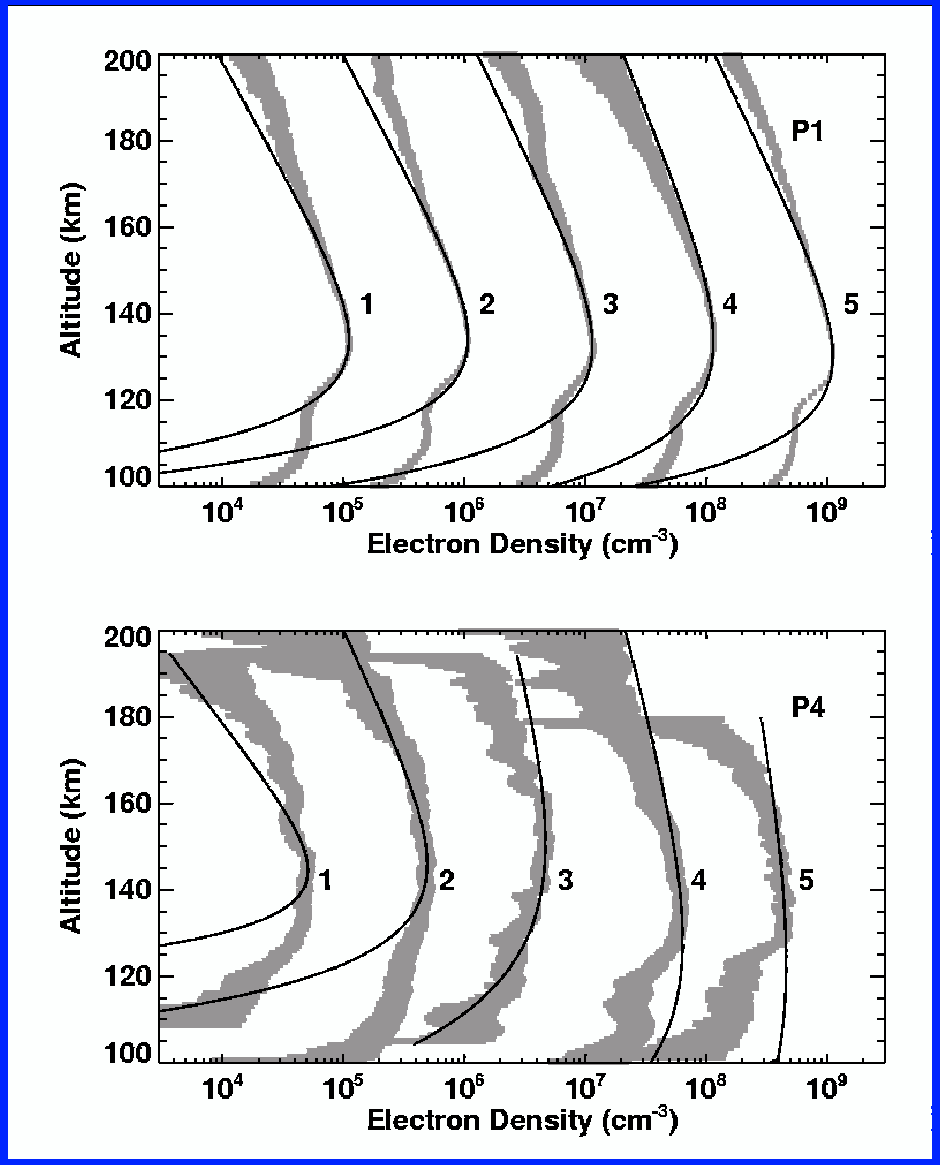

220
200
180
160
140
120
100
Height (km)
9142V11A.EDS
Latitude = 66.0S
LST = 12.0 hrs
Ls = 144 deg
SZA = 81.1 deg
1999 MAY 22 (DOY 142)
10^3
10^4
10^5
Electron Density (cm^-3)


9149E12A.EDS
Latitude = 64.85
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)


220
200
180
160
140
120
100
Height (km)
9136A27A.EDS
Latitude = 67.3S
LST = 12.0 hrs
Ls = 139 deg
SZA = 83.6 deg
1999 MAY 16 (DOY 136)
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})


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



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?