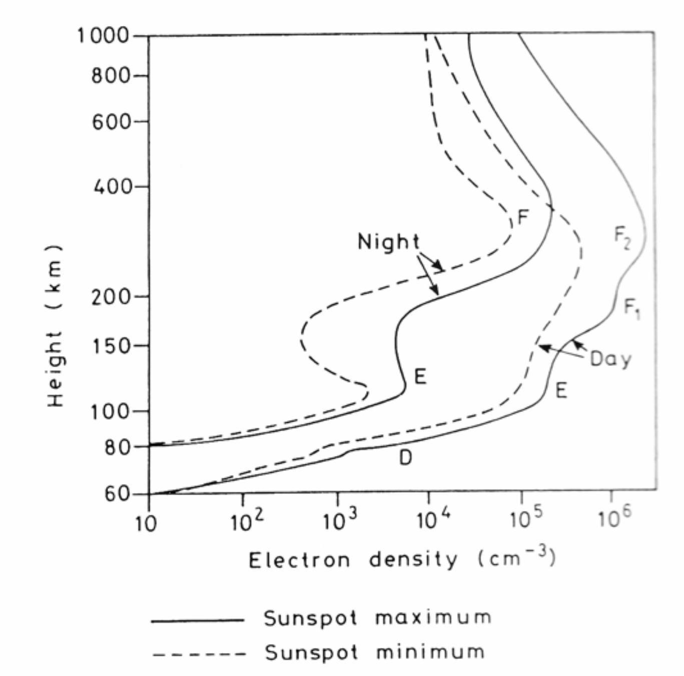
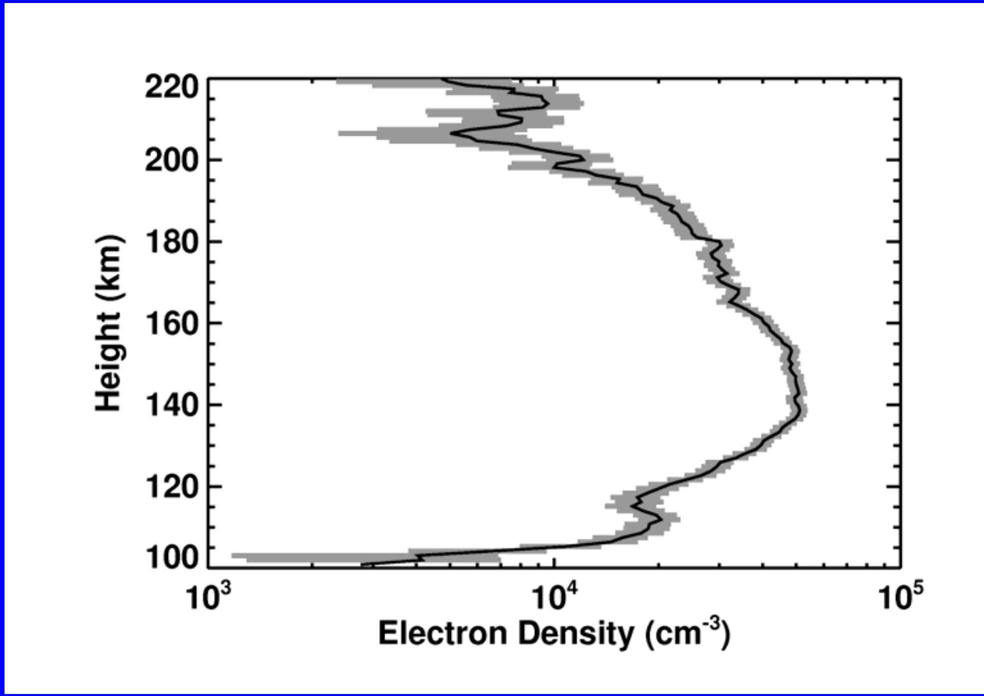
Space weather effects on the Mars ionosphere due to solar flares and meteors

Paul Withers[1], Michael Mendillo[1], and Dave Hinson[2]
1 - Boston University, USA
2 – Stanford University, USA
(withers@bu.edu)

EPSC2006-A-00190
Monday 2006.09.18 16:15-16:30
EPSC 2006, Berlin, Germany

Typical Ionospheric Profiles

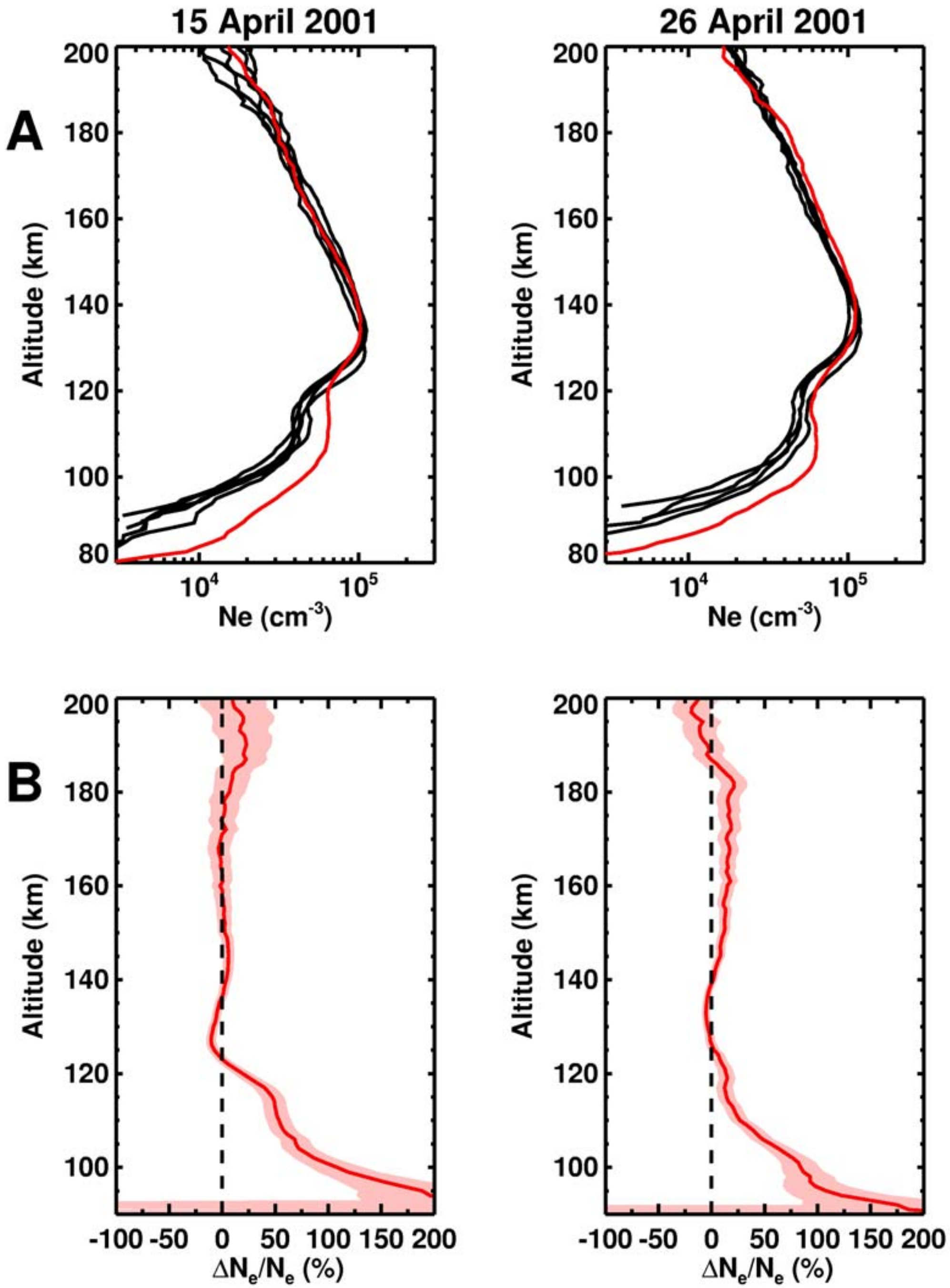




Earth (Hargreaves, 1992)
F layer due to EUV photons
E layer due to soft X-rays
D layer due to hard X-rays

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



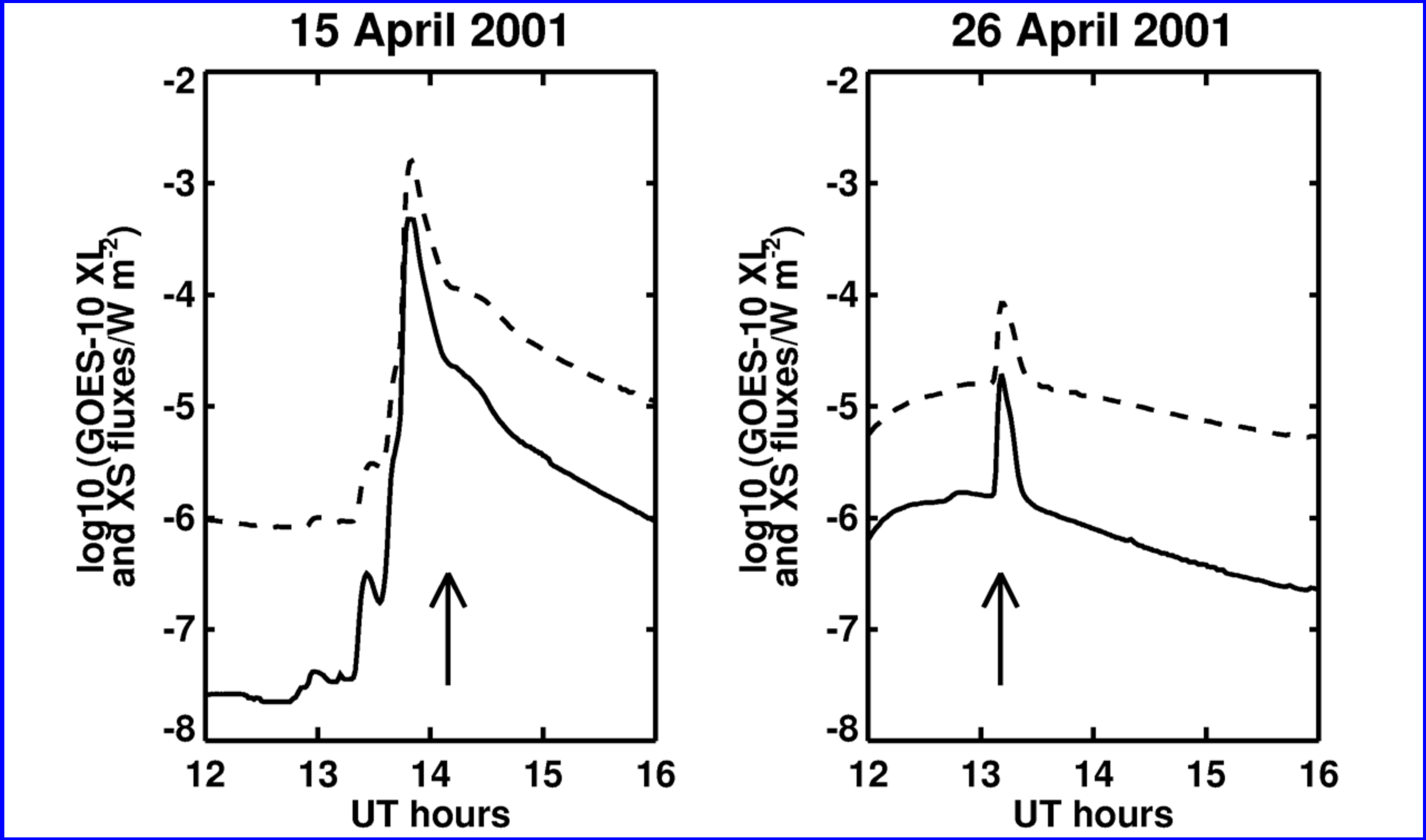
MGS electron density profiles from 15 and 26 April 2001

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

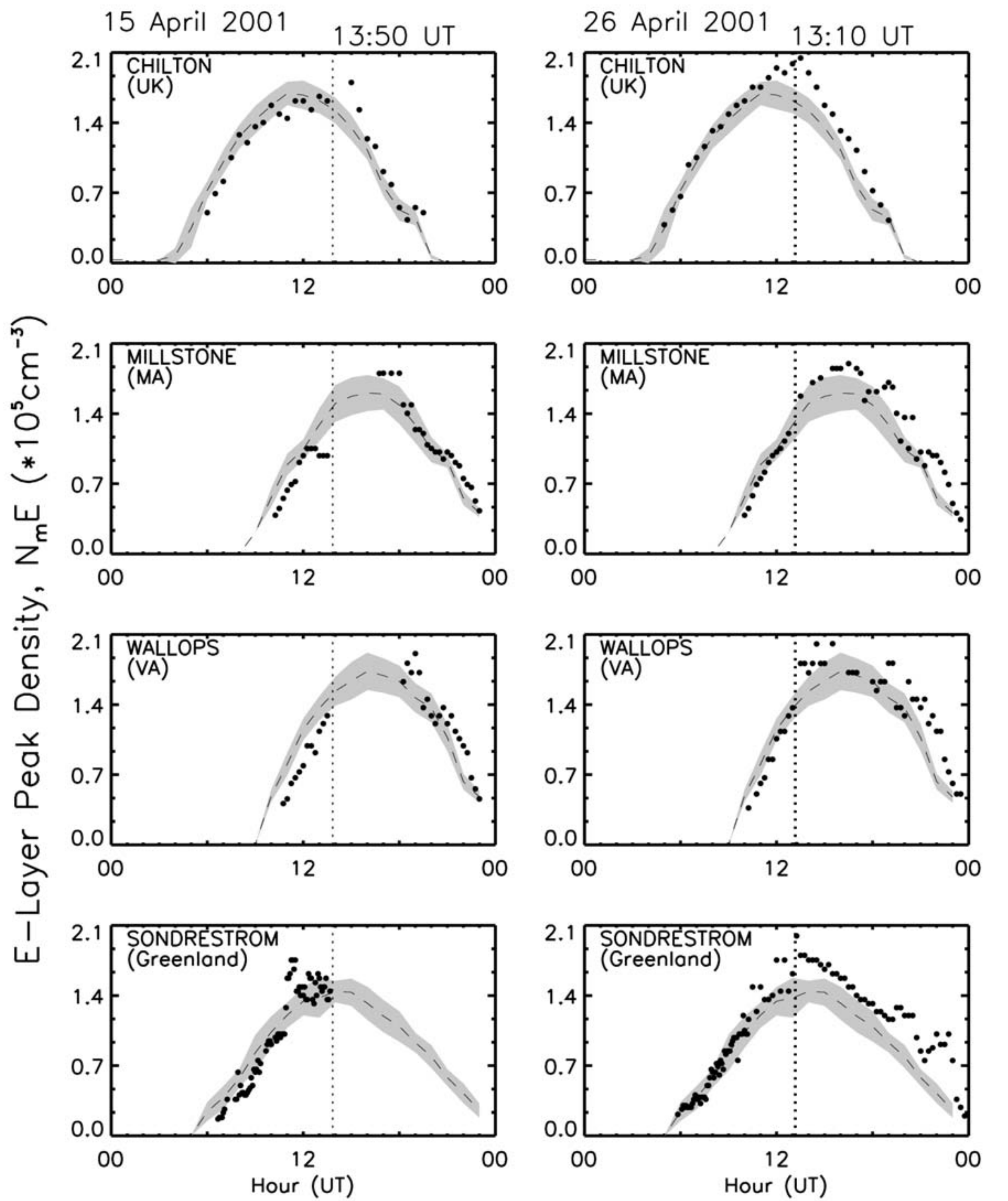


Solar flux at Earth measured by GOES satellites
Dashed line is 1 – 8 A, solid line is 0.5 – 3 A

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

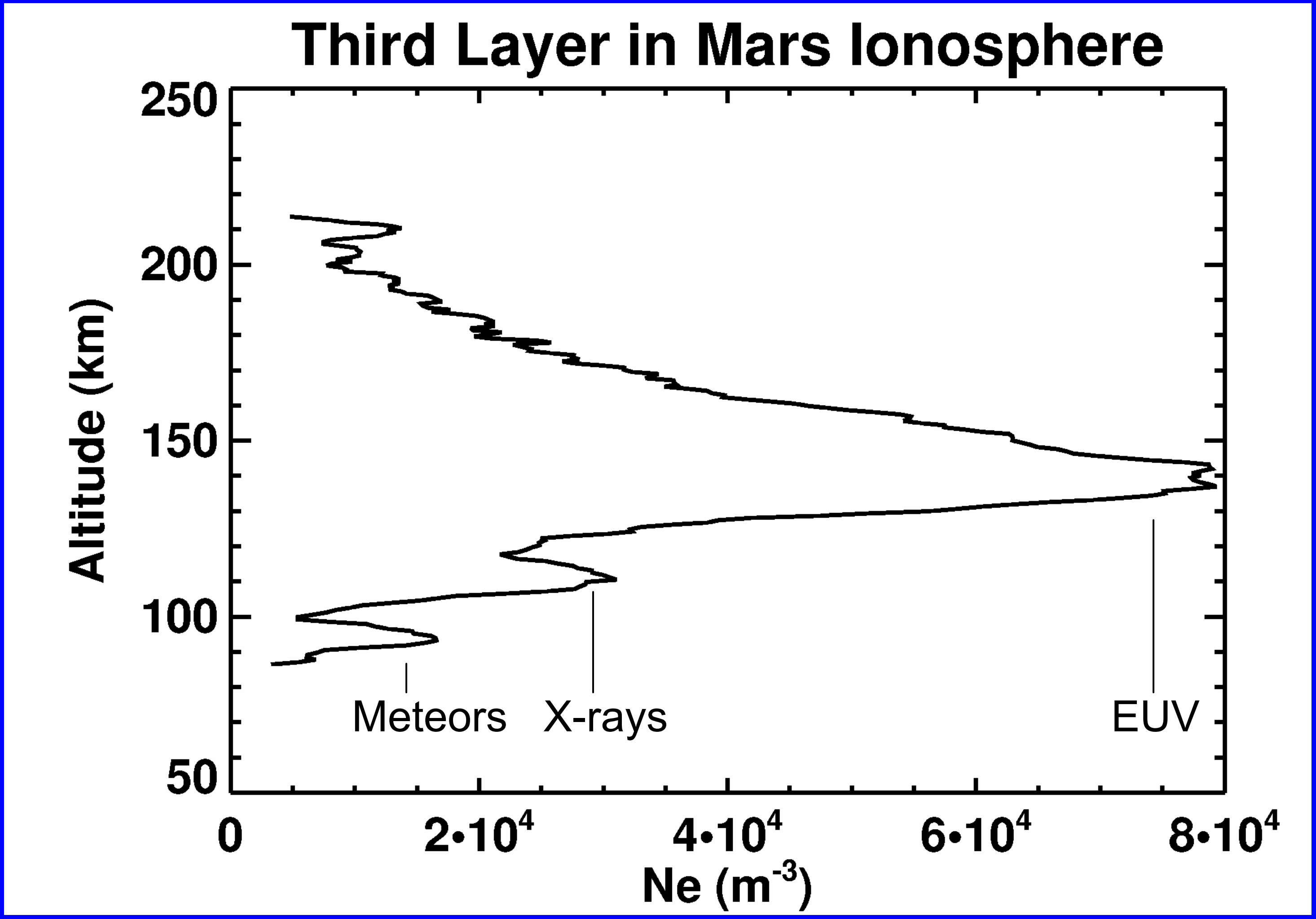
NmE increased after M7.8 flare on 26 April

Meteors at Mars

Typical altitude is 80 – 90 km
Same as models

Typical peak electron density is 1 – 2 x 10^4 m^{-3}
Same as models

Typical thickness is 10 – 20 km
Narrower than models predict
Suggests a large eddy diffusion coefficient

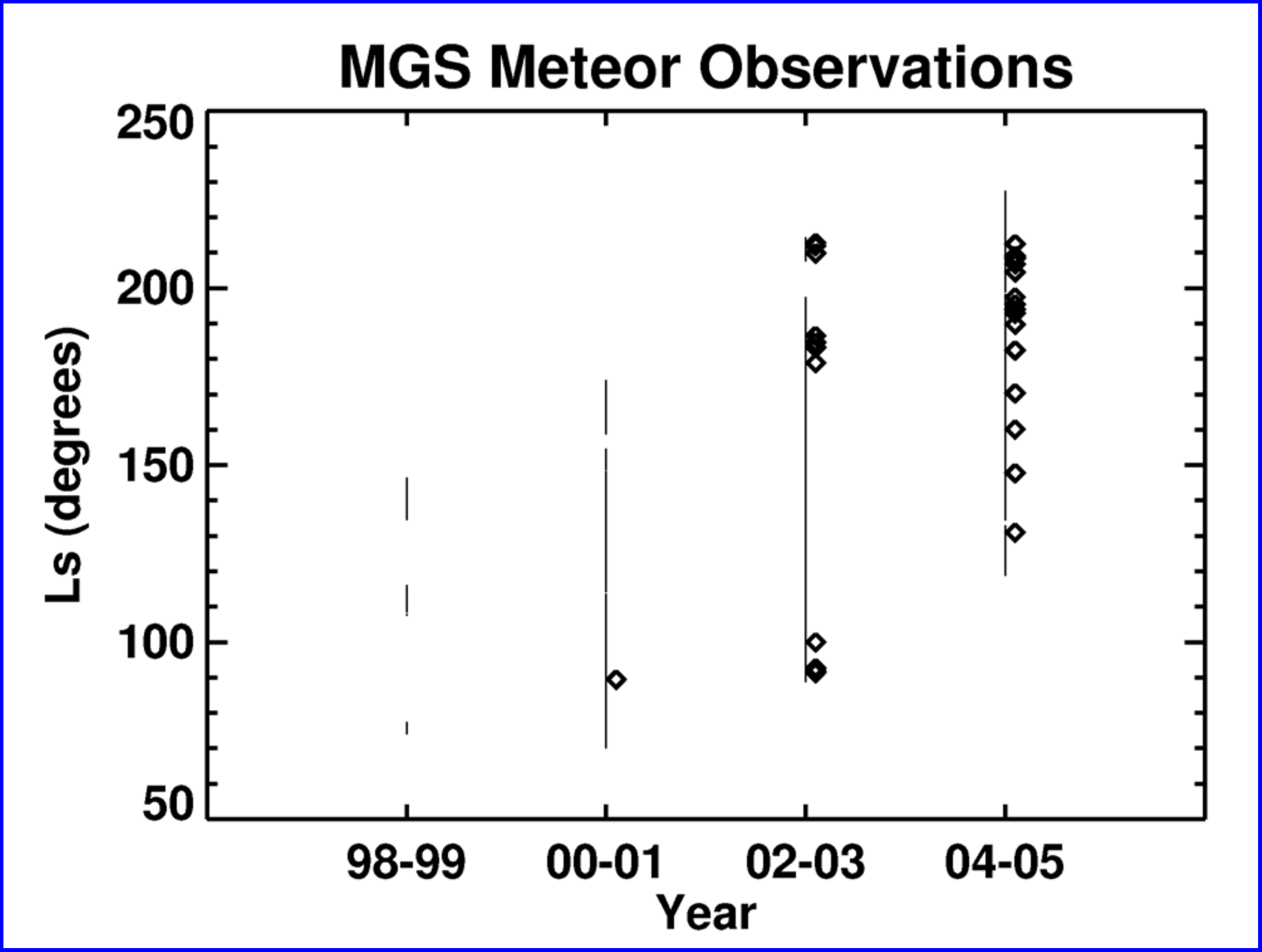


Seasonal Trends

One meteor layer every 200 profiles

Meteor layers are not randomly distributed in Ls

Concentrations at Ls~190 (Asteroid 2102 Tantalus?) and at Ls~210



meteor	0	1	11	16
total	295	1572	1882	1851

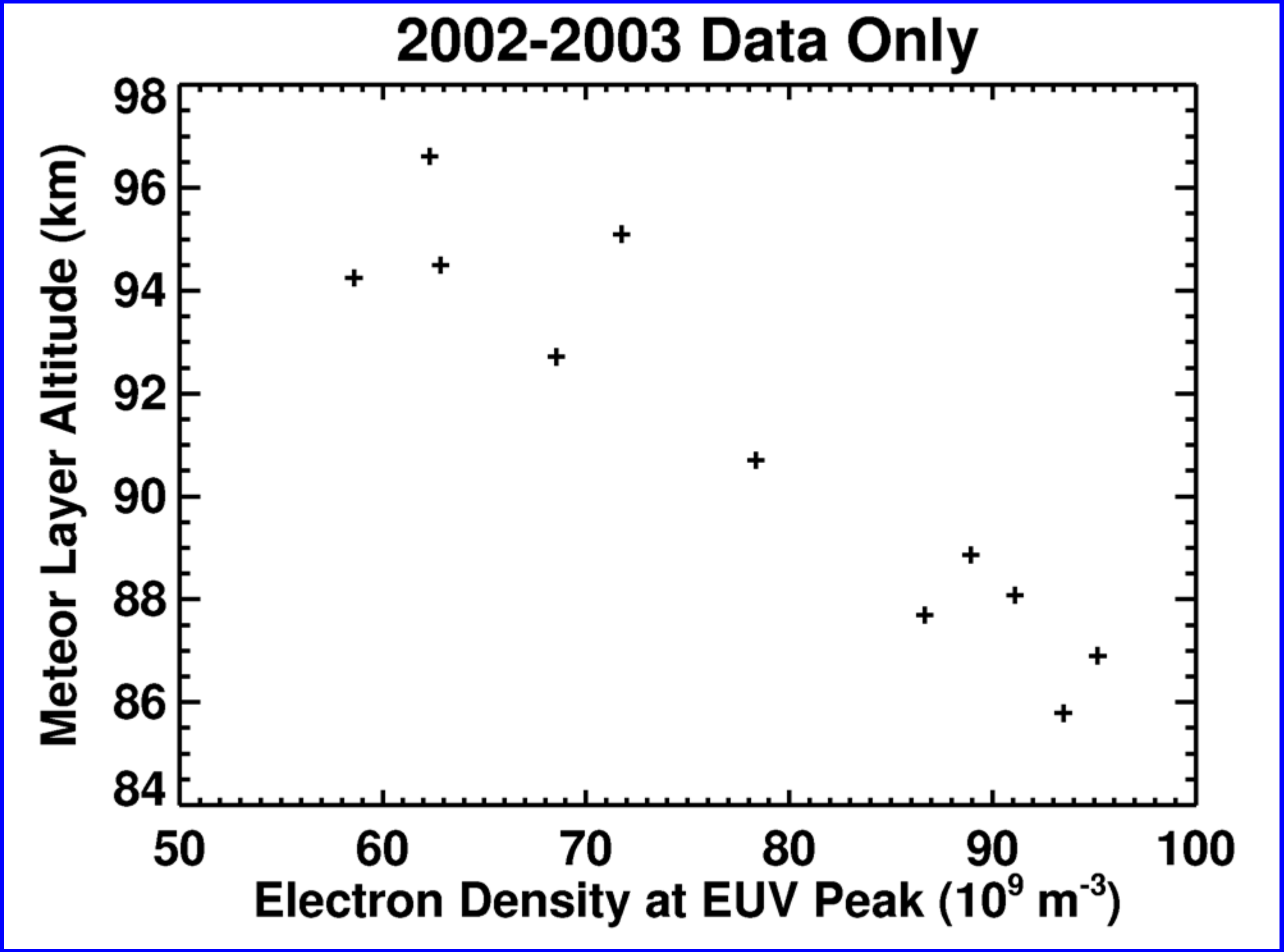
Meteor Layer Altitude

Meteor layer altitude from 2002-2003 data correlates with peak electron density

No correlation for 2004-2005 data

<u>Conclusion</u>
Something that controls meteor layer altitude varied during the observations

Something that controls peak electron density <u>also</u> varied during the observations



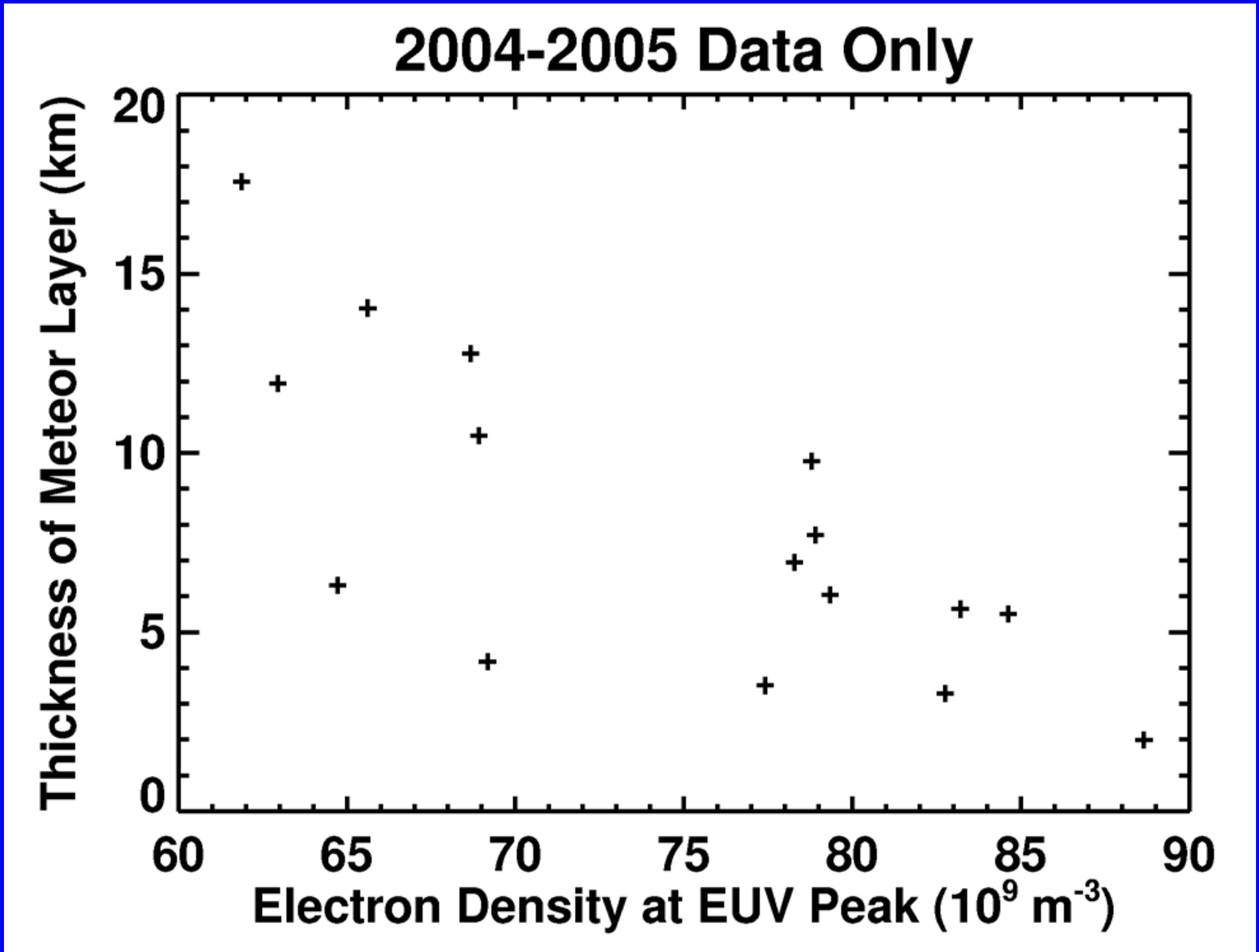
Meteor Layer Thickness

Meteor layer thickness from 2004-2005 data correlates on peak electron density

No correlation for 2002-2003 data

Implication

We can examine the observational conditions carefully and determine what variable is controlling these changes in meteor layer altitude and thickness



Conclusions

- Mars ionosphere is affected by solar flares
- Mars ionosphere is affected by meteors

- Data analysis and theoretical modelling can determine properties of solar flares and meteors. Can also determine properties of ionosphere that are involved in the ionospheric response to these aspects of space weather.