The Effects of Solar Flares on the Ionospheres of Earth and Mars

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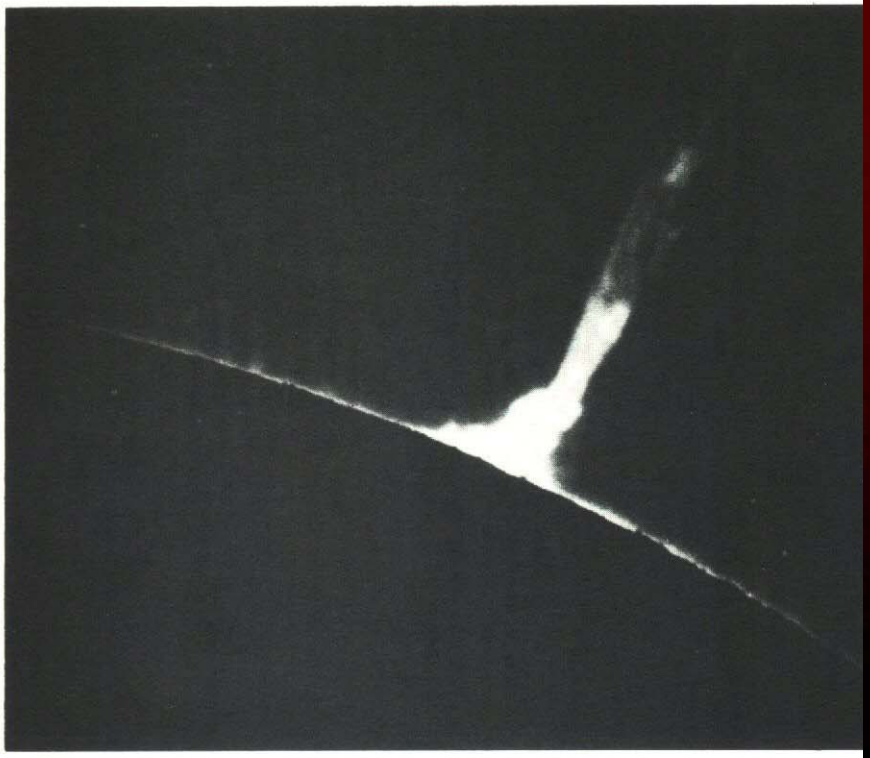
Solar Flares

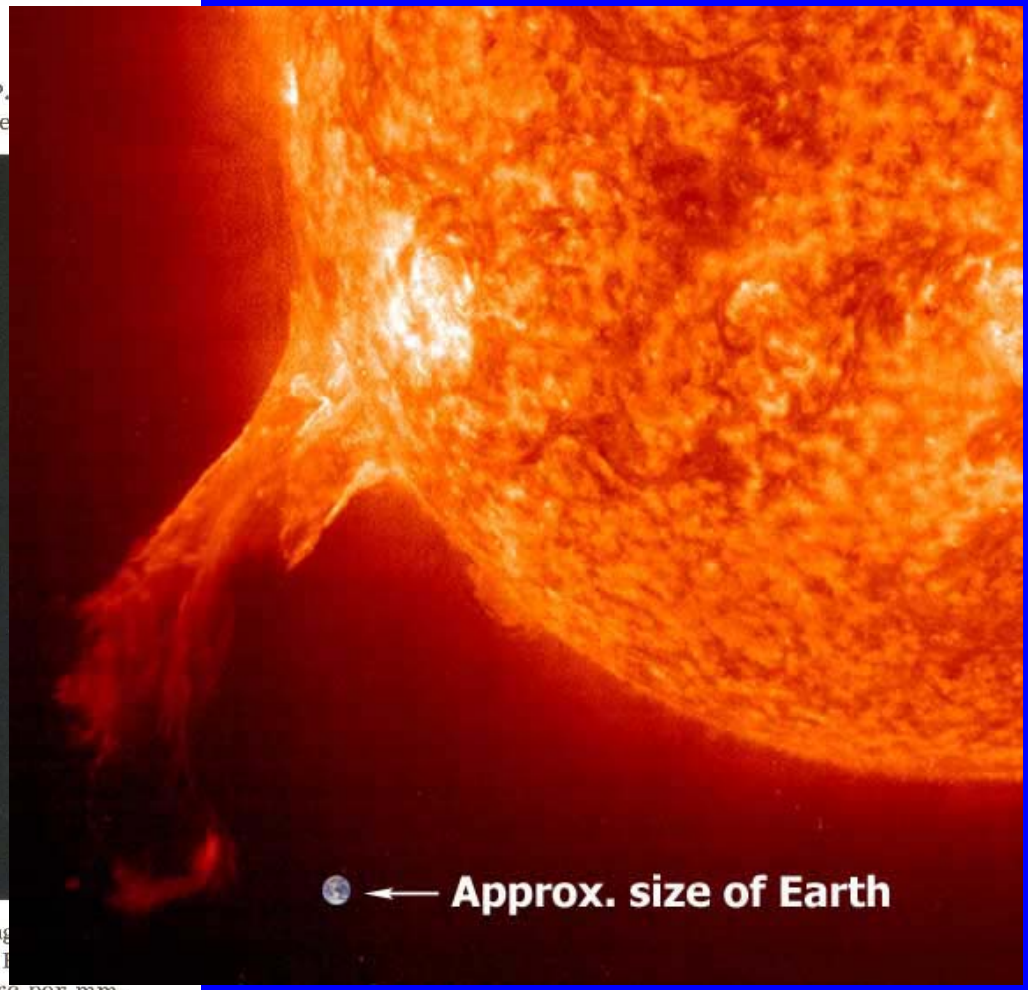
SOLAR FLARE PHOTOGRAPHED AT BOYDEN OBSERVATORY ON THE 11TH AUGUST 1972, AT 14h44m SAST

The accompanying photograph, taken by Mr. H. Bacik and Mr. J. P.
has been sent to us by Prof. A. H. Jarrett, Director of the Boyden Obse



The photograph was taken with a 15 cm aperture solar telescope using
ference filters in series giving an effective halfwidth of 15Å centred on
6563Å. The scale on the original 35 mm negative was 6.4 seconds of arc per mm,
the photograph being enlarged ten times. The film was Kodak infrared high speed
2481, and exposure time four seconds.

A Fabry-Perot interferometer was placed between the filters and the camera
to investigate the tem
fringe halfwidths - some of the H alpha fringes can be seen on the photograph to the
left of the flare. (The photograph has been processed to emphasize the flare itself
rather than the fringes which cross it).

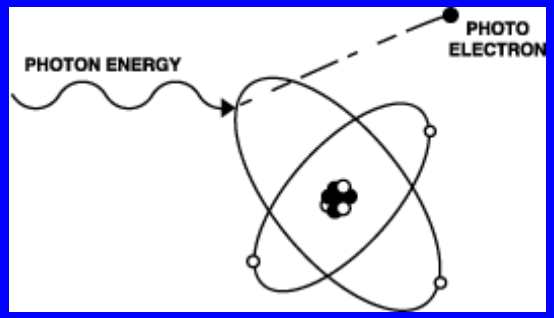


http://www.assabfn.co.za/pictures/solar_boydenflare_historical_articles.jpg

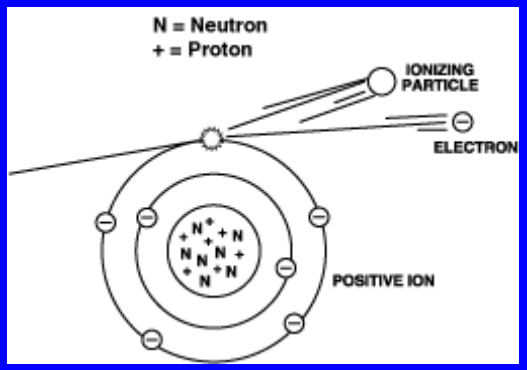
http://rednova.com/news/stories/1/2003/10/24/story002.html

Solar Flux

- Constant flux of visible photons, and lots of them, but they don't create any ions
- Variable (eg 27 day solar rotation) flux of EUV photons, which create lots of ions
- Extremely variable (minutes/hours) flux of X-rays, which penetrate deeper than EUV photons, but aren't as numerous as EUV photons.
- But X-rays can lead to secondary ionization and more ion production than expected. This process is hard to model.



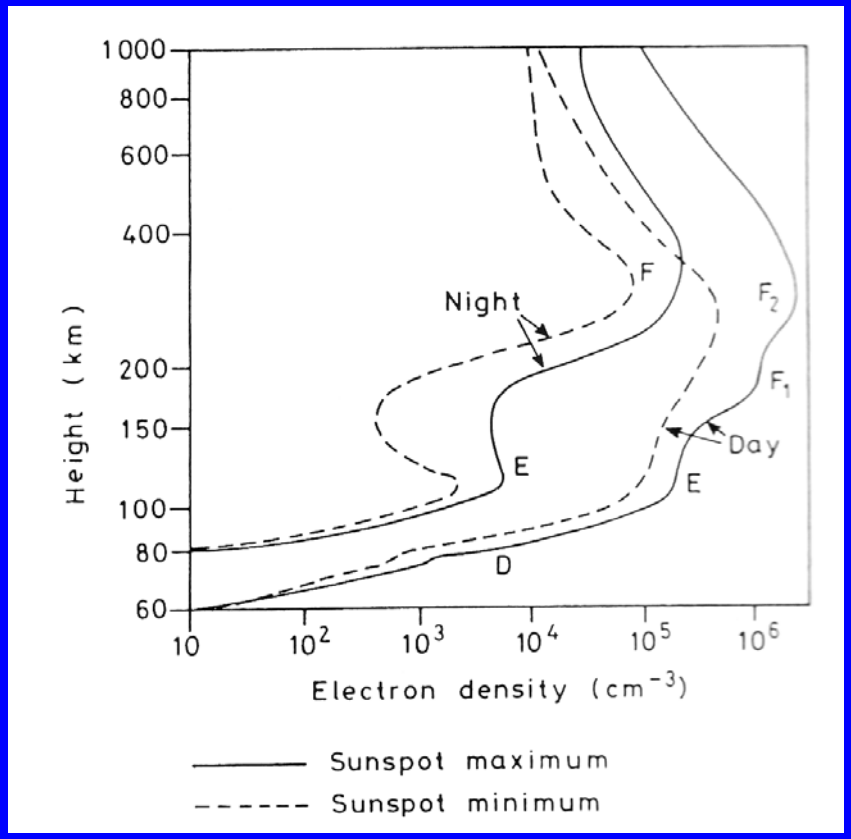
Direct photoionization (EUV and X-rays)

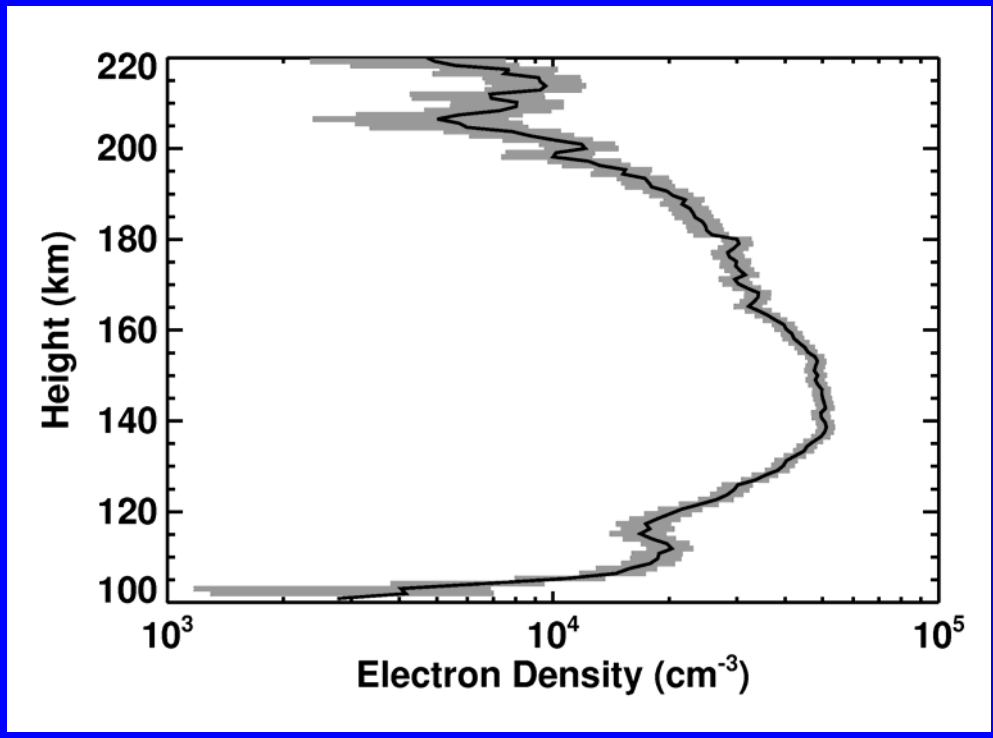


Secondary photoionization (X-rays only, ionizing particle is a hot photoelectron)

http://www.mega.nu:8080/nbcmans/8-9-html/part_i/images/chapter2/FIG2XIII.gif
http://www.mega.nu:8080/nbcmans/8-9-html/part_i/images/chapter2/FIG2IV.gif

Ionospheric Profiles

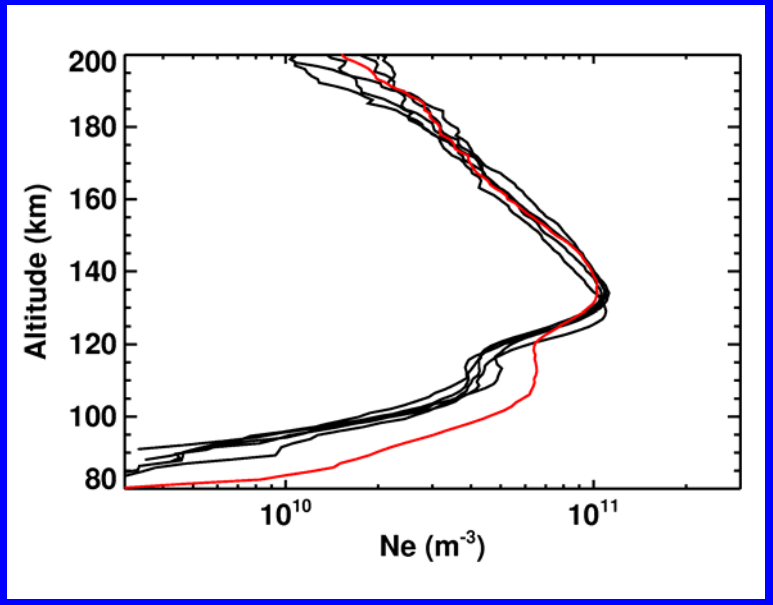


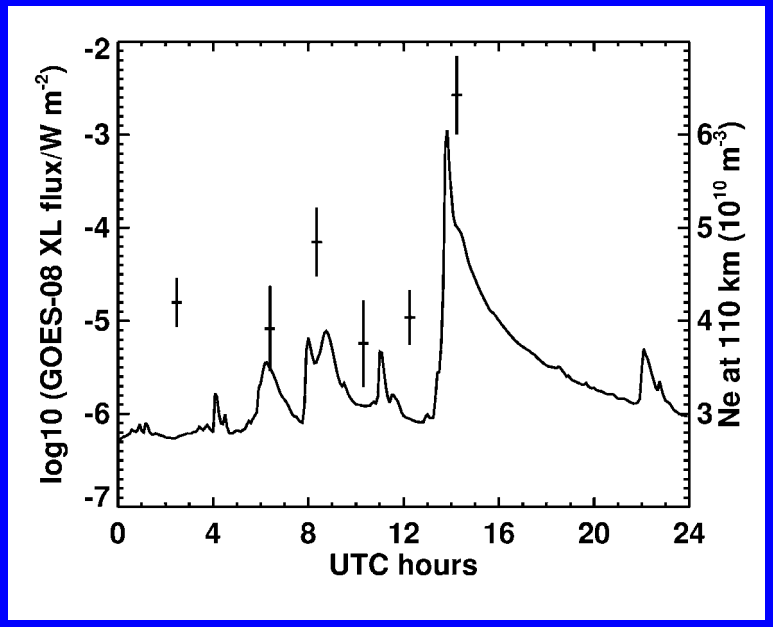


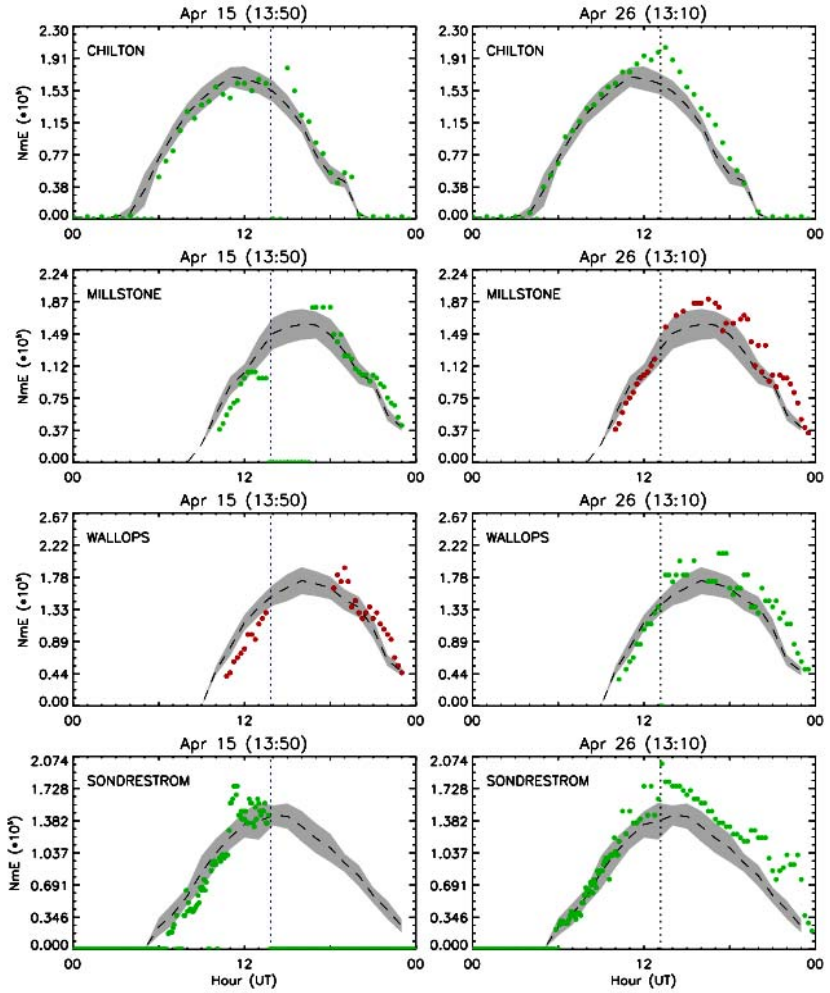
Earth (Hargreaves, 1992)
F layer due to EUV photons
E layer due to soft X-rays
D layer due to hard X-rays
(Over-simplification...)

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, often absent

Observations During a Flare







What's the point?

- Studying the response of the terrestrial ionosphere to solar flares taught us a lot about the terrestrial ionosphere - the same will be true for Mars

- How do we model secondary ionization? Simultaneous time series of observations of (a) solar flux from Earth orbit, (b) terrestrial ionosphere, and (c) martian ionosphere will provide constraints