The Effects of Solar Flares on Planetary Ionospheres

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During solar flares, the Sun's X-ray irradiance increases dramatically, often within a few minutes, and then typically decays again over periods ranging from a few tens of minutes to several hours [1]. Plasma densities in the D and E regions of the terrestrial ionosphere increase significantly during solar flares. Similar increases in plasma densities during solar flares have been observed for Venus and Mars [2,3,4].

Kar et al. investigated Pioneer Venus Orbiter Ion Mass Spectrometer data from 1979-1980 and observed that O^+ densities at 200 km altitude in the topside of the ionosphere of Venus were up to twice as large as usual during solar flares [2]. Electron densities measured simultaneously by the Orbiter Electron Temperature Probe were also enhanced. Enhanced plasma densities were not seen below 190 km.

Mendillo et al. examined martian ionospheric profiles from the Mars Global Surveyor radio occultation experiment (1998-2005). Profiles observed shortly after a solar flare showed enhanced electron densities below 120 km [3]. However, electron densities in and above the main layer were not enhanced - possibly because the observations did not occur precisely at the flare peak. Gurnett et al. measured martian peak electron density with sub-minute time resolution during a solar flare using the topside radar sounder instrument, MARSIS, on Mars Express [4]. Gurnett et al. found that peak electron density increased by 50% over several minutes, then decreased to its pre-flare value on a similar timescale.

This presentation will discuss comparative aspects of the responses of the ionospheres of Venus, Earth and Mars to solar flares, an ongoing project to simulate the response of a planetary ionosphere to the time-varying irradiance of a solar flare [5], and why the responses of planetary ionospheres to solar flares is a scientifically important topic.

References

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