X-ray Solar Flare Induced Ionospheric Perturbations Observed by VLF Sferics

Jackson C. McCormick* and Morris B. Cohen
Georgia Institute of Technology, Atlanta, GA, 30332

VLF waves are a useful diagnostic for D-region ionospheric disturbances due to their efficient global propagation. The D-region is too high for balloons, too low for satellites, and not ionized enough for radar reflections. Rocket based measurements have produced good results, but only are able to make local time and space measurements. Traditionally, ionosphere disturbances have been sensed using dedicated VLF transmitters allowing for only single propagation path analysis since there are only a handful of transmitters.

A lightning stroke, however, releases an intense amount of VLF radio energy known as a Radio Atmospheric, or sferic which propagates through the Earth-ionosphere waveguide. Lightning is globally spread and very frequent, so a sferic is therefore also a useful diagnostic of the D-region when ionized by solar flare x-ray bursts.

We present observations of lightning-generated sferics during strong solar flares. The advantage to using sferics is that many individual thunderstorms effectively act as separate VLF transmitting sources. During the solar flare there is a significant change in magnitude and frequency content of sferics. This disturbance varies with distance from the source. The difference in magnitude and relative compression of these sferics have local maximums and minimums, and appears to oscillate with distance. We also consider the change in frequency content as a function of solar x-ray flux, time of day, distance and angle of arrival. Taking these parameters together, the spatial effect of solar x-ray flares on the ionosphere can be investigated. We utilize modeling of the Earth-ionosphere system to compare to the experimental data.