Effects of Solar Flux on VLF Lightning Sferic Propagation

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Lightning strokes release intense bursts of Very Low Frequency (VLF, 3-30 kHz) radio energy, known as 'sferics'. Accurate and efficient geolocation of global lightning using sferics and a network of VLF receivers has recently become possible [1]. This advance allows us to address a fundamental problem: an accurate picture of sferic propagation. In particular, summing the shapes of many sferics with the same propagation path provides a useful measurement of VLF propagation conditions [2]. Sferic propagation is affected by many different environmental conditions, including solar flares. We utilize global lightning data from the GLD360 network [3], combined with VLF sferics observed by the AWESOME instrument [4], and x-ray flux data from the GOES satellite, to track the magnitude, shape, and propagation velocity, of a VLF sferic in the presence of solar flares.

1. Summary

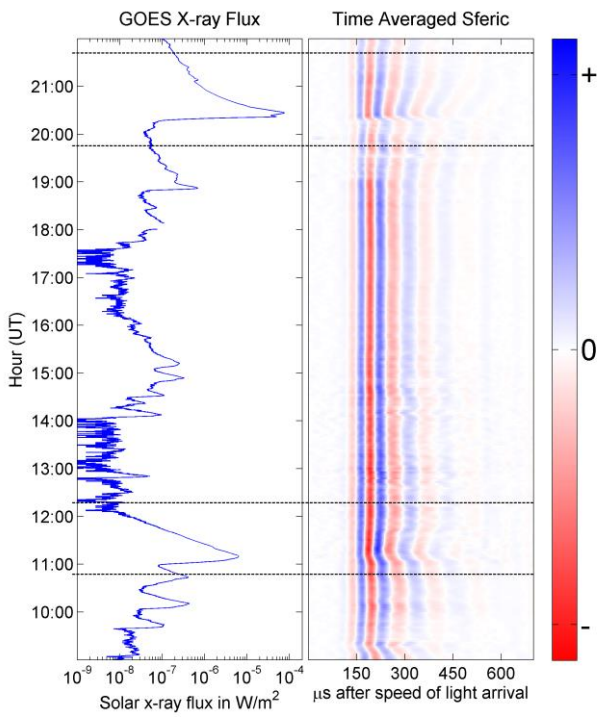

Figure 1. The plot compares the x-ray flux taken by the GOES satellite during the daylight hours to the VLF sferic propagation. Two intense solar events occur which affect sferic propagation throughout the day which are shown by the dashed lines. Along the y-axis of both plots is the UT hour. The plot on the left shows the x-ray flux in W/m^2, while the plot on the right shows time after the speed of light arrival of the sferic. On the right plot, blue indicates a positive magnetic field portion of the sferic, while red indicates a negative.

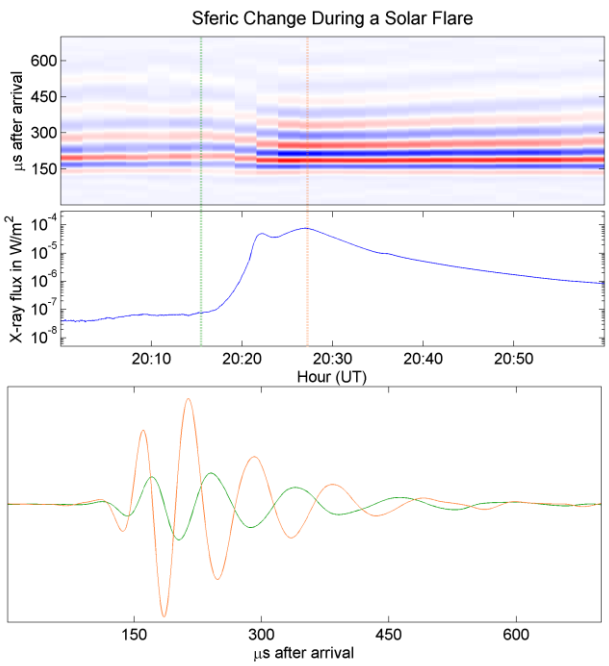

Figure 2. This figure is a zoomed in portion of the solar event from 20:00-21:00. Along the x-axis of the top two plots is one hour of time during a solar event. The y-axis of top plot is time in microseconds after speed of light arrival of the sferic. The middle plot's y-axis is the x-ray flux in W/m^2 as recorded by the GOES satellite. The bottom plot is the sferic shown by the cross section drawn in the top two plots with a dashed line. The green sferic is before the solar flare occurred, and the orange is after the solar flare occurred.

2. References

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[2] Cummer, S. A., U. S. Inan, and T. F. Bell (1998), Ionospheric D region remote sensing using VLF radio atmospherics, Radio Sci., 33, 1781-1792.

[3] Said R. K., M. B. Cohen, U. S. Inan (2013), Highly Intense Lightning Over the Oceans: Estimated Peak Currents from Global GLD360 Observations, J. Geophys. Res. Atmospheres, 118, doi:1002/jgrd.50508

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