FORECASTING SOLAR ENERGETIC PARTICLE EVENTS USING CHANGES IN ELECTRON FLUX

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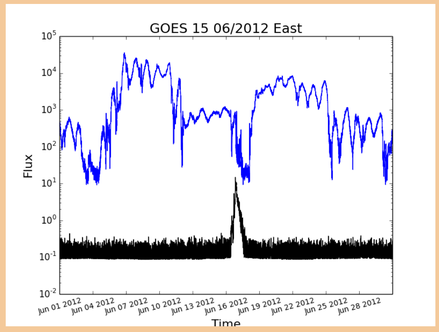
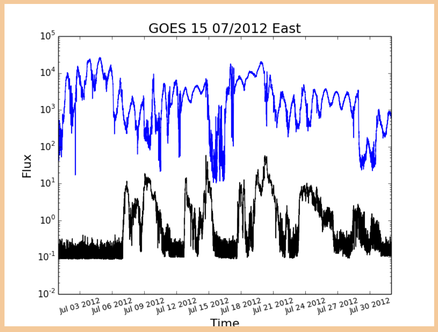
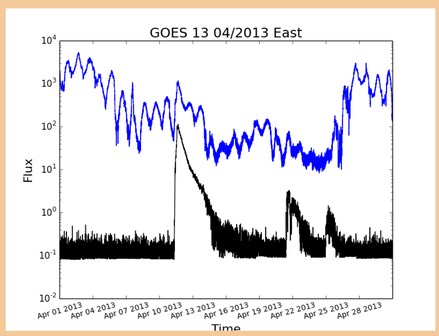
Introduction:

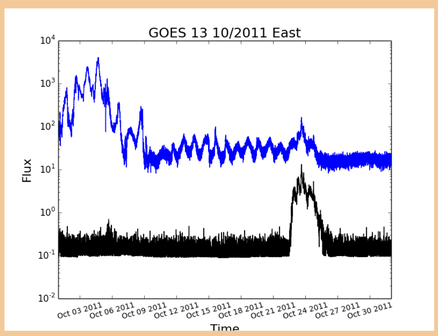
Given our growing dependence on satellite technology for communication and innovation, the potential interference from Solar Energetic Particle (SEP) events is a growing concern. Using observations from the GOES 13 and 15 satellites, we have been comparing proton data associated with Solar Energetic Particle (SEP) events with electron activity around the times in which SEP events were observed. We analyzed the 26 NOAA classified SEP events occuring from March 2010 to March 2013.

Comparison of Electron Flux with Proton Flux During SEP Events:

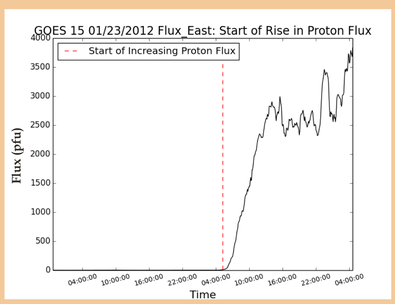






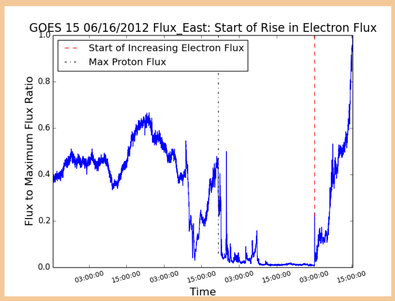


<u>Proton flux</u> = black line protons with energy of >10 MeV
<u>Electron flux</u> = blue line electrons with energy >2 MeV



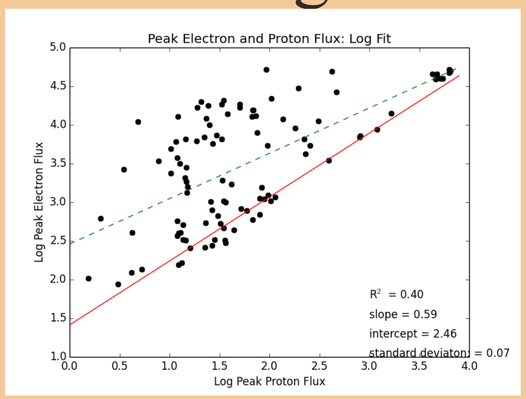
<u>Proton flux start time</u>
First time flux reaches 10 proton flux units (pfu).

<u>Electron flux start time</u>
The flux to maximum flux ratio is the flux for each observation divided by the peak flux. The electron start time is defined as the time where the flux to maximum flux ratio exceeds a defined threshold, for example 0.5.

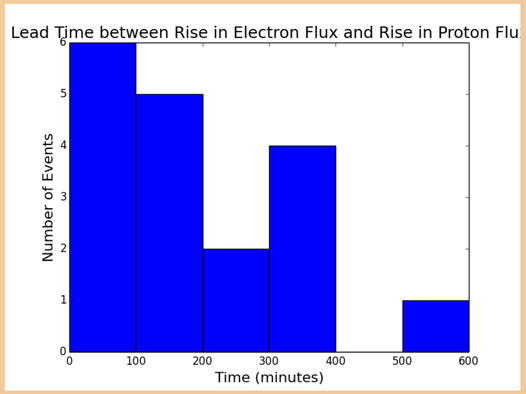


***However,* this method can not be used for real-time predictions because it depends on knowing the peak flux in advance.**

Determining Electron Flux Lead Time:



The Scatter Plot of maximum proton and electron flux. We fit a line using a linear least-squares method. The green line is the fit through all the data and the red line is the fit through the minima. There's a strong correlation between the peak proton and peak electron flux. The R^2 value for the full distribution is 0.4.



Histogram of the time between the rise in electron flux and the peak proton flux. The rise in electron flux was determined by using the fit to the minimum as shown in the plot at left. The average time delay is 180 minutes. The time delay ranged from 17 minutes to 8 hours.

Conclusions:

We found a correlation between peak electron and peak proton flux. Using this relationship, we were able to find an average lead-time from the increase in electrons to the peak proton flux of 3 hours. This technique can be applied to forecast the peak of future SEP events. More work needs to be done to determine how to apply the technique for real-time forecasting and fully characterize the limitations for instance 8 events did not have electron flux high enough to fit into this model.

Future Work:

We need to determine whether the electron flux rises to these levels during times where there is no increase in proton flux. As a next step we would analyze data for the 123 radio bursts occuring during this time period (studied in Winter and Ledbetter, in prep).

Acknowledgements:

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