Real Time Solar Flare Analysis

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Preface: Amongst the instruments distributed through the ISWI are the SID space weather monitors. Designed to detect changes to the ionosphere caused by solar activity, these monitors are being distributed to high school and early college students around the world. Over 700 instruments have been placed, and requests continue to come in.

Many of the students who receive these monitors are doing amazing research with them. What follows is an article by a high school student at Commack High School in New York, USA. The student author, Anthony Bisulco, started using a SID monitor last year and developed an interest in solar flares and radio technology. He is in 11th grade now and has put together an elaborate science project based on his SID. Earlier this year he entered his project in the very competitive Long Island Science and Engineering Fair. His project, "A Practical Notification System to Identify Incoming Sudden Ionosphere Disturbances", won first place in his category! He was selected to attend the International Science and Engineering Fair held in Phoenix. Anthony's teacher, Richard Kurtz, reports "This is a fantastic opportunity and honor and we thank you for your support over the years." Congratulations go both to Anthony and to his teacher, Richard Kurtz, who has encouraged many high-achieving SID students over the years.

Below is an article Anthony has written about his project.

Deborah Scherrer
Stanford University Solar Center
Director of the SID Project

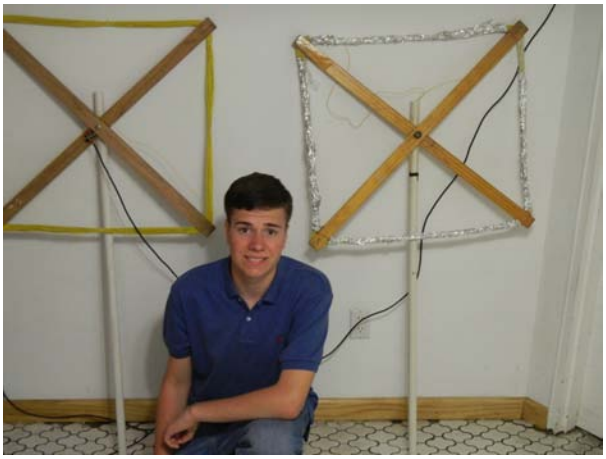


Figure 1. Antennas built to obtain Very Low Frequency waves

My name is Anthony Bisulco and I am an 11th grade student at Commack High School on Long Island, NY. This year I became interested in radio propagation because I had just finished getting my ham radio licensee. While learning the material for my ham license I read about radio blackouts, which intrigued me. Radio blackouts occur when particles, coming from solar flares from the Sun, hit and ionize the Earth's ionosphere. Soon after I began researching different radio blackout occurrences I realized that not

only do solar flares have the potential to affect radio waves on Earth but they also can have major negative impacts on a wide range of electrical systems. When I read about an incident in Quebec in 1989 where the entire Quebec power grid was knocked out by a solar flare, I was curious to see if there could be a way to warn people when these events were about to occur to reduce the damaging effects of solar disruptions.

I conducted a literature search to find out if there were any methods in use to predict solar flares. One method currently used employs the Solar and Heliospheric Observatory (SOHO) satellite [*the Stanford group has the MDI instrument on SOHO*]. I questioned what would happen to the ability to warn people of solar flares if a solar event or cosmic rays disabled SOHO. Given this possibility I decided to design a simple inexpensive warning system. My teacher introduced me to the Stanford Solar Center that makes available a device through the Society of Amateur Radio Astronomers (SARA) known as the Super SID. The Super SID is a program that detects solar flares using Very Low Frequency (VLF) wave propagation. I built a 1-meter loop antenna with 50 turns of copper enameled wire with a custom designed PVC base. I connected the antenna wires to the Super SID and computer and tried to collect data. I was initially disappointed because I did not receive any of the signals from the VLF stations. So I contacted the Stanford Solar Center support team and after I spent the summer debugging my system. I finally figured out that the webcam on my computer was the problem because it was recording the audio data being sampled.

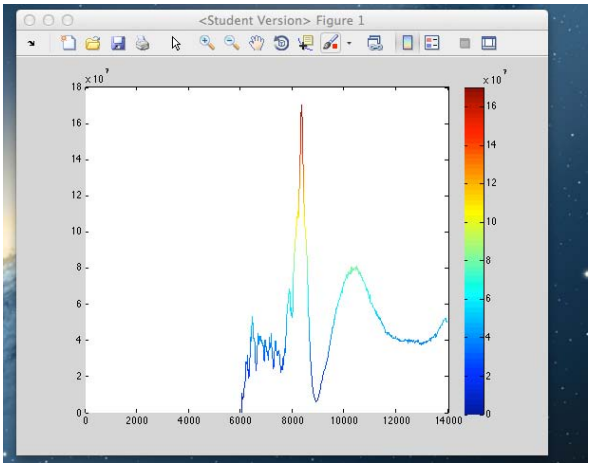
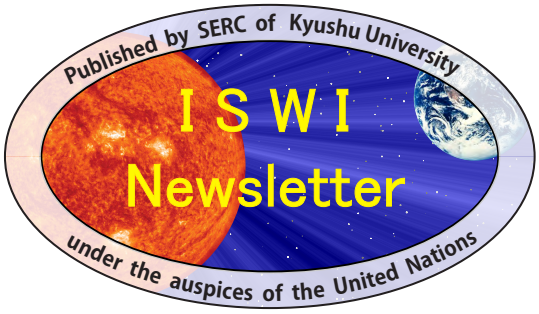


Figure 2. Solar Flare Data Real Time Analysis

Now with a working system I was finally able to start my investigation. I started to collect data though I became frustrated with having to plot the data and look for solar flares manually and I wondered whether or not plotting could be done automatically. At this point I developed my research goal, which was to develop a computer program that could take in the signals from the Super SID in real time and identify the solar flare from the plotted data. To do this I first found that I had to isolate one station to look for an increase in signal strength. I used a mathematical transformation called the Fourier transform that takes the received signals from the voltage domain and puts it into the frequency domain. I then took one of the frequencies from the Fourier transform and plotted against time to look for increase in signal strength. I had the computer calculate the rate of change of the Fourier function to help identify this. To make this more universal I then created a twitter feed that indicates in real time if a solar flare has erupted. This could warn

people, who have responsibilities related to electrical and communication systems that could be affected by solar disturbances about an incoming flare.

Acknowledgements: I would like to thank Richard Kurtz, Doctors Fred and Barbara Kruger and my parents. Richard Kurtz has guided me and helped me so much throughout the past year. Without Richard Kurtz I may have not ever have been able to begin my research on solar flares which has allowed me to gain a wealth of knowledge in many different disciplines of science. I would also like to thank Doctors Fred and Barbara Kruger for helping me understand the theory behind the SID receiver and for helping me improve my research paper and board so that I could perform my best at science fairs. Finally I would like to thank my parents for always supporting me in no matter what I do.



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