CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)
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Project Number
35050

Project Title
Advanced Warning for Solar Flares: Utilizing Sudden Ionospheric Disturbances to Detect and Measure Solar Flares

Abstract

Objectives/Goals
To detect and measure the strength of solar flares using the interactions between Very Low Frequencies and the Ionosphere in order to provide early warnings for the harmful effects of solar flares.

Methods/Materials
1. Set up an antenna of sufficient size to reliably detect one or more station of Very Low Frequency wavelengths.
2. Allow the antenna to collect data on strength of VLF's over the course of several months.
3. Analyze this data by measuring daytime peaks in wave signal strength and the base of such peaks, subtracting the base value from the peak value in order to procure the signal strength differential, graphing it alongside class of corresponding flares and finding the correlation.

Results
Class = 1.757*1.0002^(Signal Strength Differential)
This equation has a correlation of .927, which is indicative of a strong empirical correlation, especially considering the number of data points (25 separate solar flares). The percent error for c-class flares was generally around .1, the error for M-class was around .04, and the error for the sole X-class and the higher M-class flares was around .4. There were outliers in the data set, which likely resulted from forms of interference, including fluorescent lights and microwaves.

Conclusions/Discussion
The correlation (.927) was strong enough that it is fair to say that there is an empirical correlation between signal strength differential and the strength of the solar flare. Furthermore, the antenna was able to accurately detect every significant solar flare over a span from December 1 to March 11 (the cutoff for this data). It was also immediately apparent, even without fully examining data, about what class the flares were. This ease of observation means that this apparatus makes it immediately apparent whether or not there could be a flare that could disrupt human activity. Since solar flares do disrupt electric grids as well as communications satellites, it is important to monitor them. Interference is an important consideration. The antenna works best during weekends or school vacations. However, it is important to consider that the antenna can still measure relatively small solar flares during the schooldays, even with interference. Interference is also easily distinguishable from solar flares on graphs. This system of detecting solar flares works almost perfectly, and it works to measure them with a .927 correlation.

Summary Statement
This project uses the relationship between Very Low Frequency waves and Sudden Ionospheric Disturbances to detect solar flares, which can aid in preparations for their harmful effects, including radio blackouts and possible grid failures.

Help Received
the aid, advice, and equipment of Mr. Philip Deutschle and the Salinas Observatory