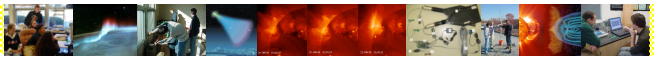


Greater Cincinnati Solar Observers Network

Jeff Rodriguez
Anderson High School

Eric Towers
Summit Country Day School

Marty Wells
LaSalle High School

Davis Tapp
Madeira High School

Barry Riehle
Turpin High School

Project Description

Students will conduct an interdisciplinary scientific investigation by maintaining experiments that combine astronomy, particle physics, and magnetism. Students will make realistic connections between the individual physics content areas and the scientific community.

Each of the participating schools will either measure or obtain from another school the following data sets: cosmic ray flux, radio signal observations, sudden ionospheric disturbances, and Earth's magnetic field strength. Students will make predictions and conclusions by correlating the various data types to solar activity. A website will be developed for student communication and posting of data. Student cosmic ray data will be uploaded to the QuarkNet Grid, radio bursts data to NASA Project Jove, and SID data to the Stanford Solar Center. Students will compare local and regional data to national data submitted by other students and professional space weather agencies.

Student's Role

The students will engage in scientifically oriented questions and will maintain the project experiments, with teacher advisors providing guidance as needed. Students will be asked to answer their research questions based upon their data sources and the relationship between solar flares and the collected data. Each school team will prepare educational units for the benefit of the other teams. This gives students a chance to be "experts" in certain areas and an opportunity to teach others. Students will create presentations using local, regional, and national data sets. Students running the same experiment at different schools will be expected to collaborate with each other to formulate reasonable and logical explanations. They will be expected to ask questions regarding the data and draw possible conclusions based upon the data sets.

The students will build/set up preselected experimental equipment modules: Vernier radiation monitors (pending inability to obtain more QuarkNet boards) or QuarkNet DAQ muon detector for cosmic ray studies, magnetic field sensors for detecting the Earth's magnetic field, and a Project JOVE receiver for solar radio emissions. Students will upload their data to the QuarkNet Grid, NASA SON, and to our local webmaster for the project. Students working with the Vernier radiation monitors will compare results with the QuarkNet detector. It is hopeful that this group will be able to contact other high schools in the Grid to obtain comparative data for our region. Collected data will be analyzed and correlated by the student groups to check their hypotheses and draw conclusions.

Student Accomplishments

Students are uploading cosmic ray data to the QuarkNet Grid in order to share data, graphs, and posters and collaborate with other students nationwide.

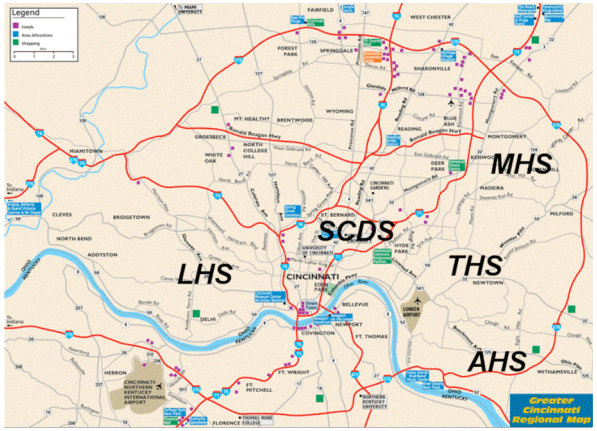
A second muon detector within our network will confirm local and national results.

SOLARSID data is uploaded to the Stanford Solar Center and radio burst data is uploaded to the NASA Project JOVE Archives.

Students are communicating with scientists in order to understand and interpret their data.

An article about the local project at Anderson High School was published in the *Forest Hills Journal* on Jan. 12, 2007.

AHS data can be found at: http://www.foresthills.edu/anderson/rod/swe/index.html

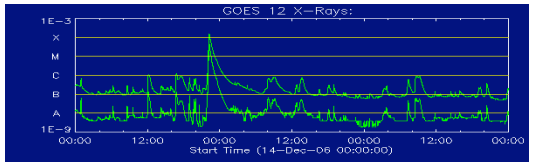


Sample Student Weekly Report

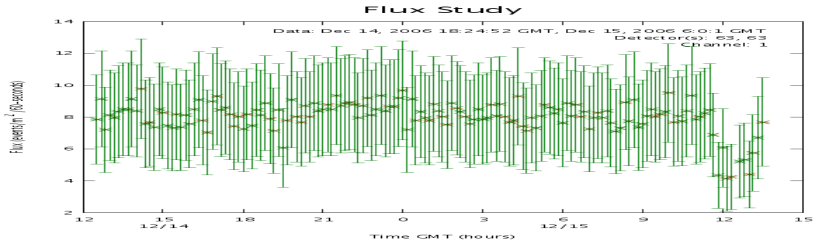
December 2006 Cosmic Ray Report
Tracey Mulroney, Jason Senko, Corey Larrison

Data from GOES satellite

14-DEC-06 348 11:56 12:10 12:29 C1.0
14-DEC-06 348 16:36 16:49 16:59 C1.2



The graph and data above show the C events that occurred on December 14, 2006. The significant dip in our data occurs about a day after the actual reported event from the GOES website. There were only two C events from the period of December 14th through the day of December 16th. At the beginning of the 15th (very late in the evening of the 14th), there is an extreme event that even goes into the X region.



This graph shows the muon flux detected at Anderson High School from the evening of December 14, 2006 to the morning of December 15, 2006. At around 12 GMT a dip in the muon flux was detected. This shows a possible Forbush decrease in the muon flux.

Sample Student Summary

Philip Campos

Geomagnetic K and Solar Index Summary

The correlation between sunspot and geomagnetic activity has been observed using data collected by the Space Environment Center (SEC) on an NOAA scale. The observations of geomagnetic activity are based on the K-indices derived at the U.S. Air Force Space Forecast Center from recorded measurements of the Boulder-NOAA magnetometer, made available through the cooperation of the Geological Survey of Canada (GSC) and the U.S. Geological Survey. The K-index complies with NOAA Space Weather Scales and simply measure the level of geomagnetic activity. The observations of sunspot activity are derived from the SEC's GOES satellite program, which measures various space weather-related solar activities. The directly observed measurements were of the sunspot number, or sunspot index. By creating data graphs using these recorded geomagnetic K-indices and sunspot indices, correlations were observed between geomagnetic activities within the Earth's magnetosphere in relation to solar activity as observed through sunspots.

Cosmic Ray Detector

As cosmic rays bombard the atmosphere, they cause high-energy particles to decay into muons, which shower down toward Earth. These muons are then detected by the cosmic ray detector and recorded to the computer. During a cosmic event, the number of muon hits will decrease because the magnetic field will strengthen itself, thus deflecting cosmic rays from reaching the atmosphere.

The muon information was recorded and compared to data from the SLAC site to search for correlations.

SOLARSID Summary

The free electrons in the ionosphere have a strong influence on the propagation of radio signals. Radio frequencies of very long wavelength (very low frequency or "VLF") "bounce" back off the ionosphere, thus, conveniently for us, allowing radio communication "over the horizon" and around our curved Earth.

The ionosphere reacts strongly to the intense X-ray and ultraviolet radiation released by the Sun during a solar flare, solar storm, or coronal mass ejection. By monitoring the signal strength from distant VLF transmitters and noting unusual changes as the waves bounce off the ionosphere, we can monitor and track these disturbances.

To monitor a VLF signal, we need a radio receiver that can "tune" to very low frequency stations, an antenna to pick up these VLF signals, and a computer to keep track of the data. Since most consumer radios cannot pick up the very low frequency signals, we need to build our own radio receiver and our own antenna. This combination of receiver and antenna we call a Sudden Ionospheric Disturbance (SID) monitor.

Radio Jove Summary

The Radio Jove program is responsible for detecting solar radio bursts by analyzing radio waves received by the antenna at 20.1 MHz. During a solar event, the Sun will release radio waves along with other energy and particles. These radio waves then travel to Earth and are picked up by the detector. The data recorded by the detector is then compared to data from around the country to confirm it wasn't merely a local occurrence.