Using THEMIS and ACE Data for Authentic Student Research Projects in the Secondary Classroom

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Abstract

The Time History of Events and Macroscale Interactions during Substorms (THEMIS) Mission Education and Public Outreach (E/PO) program has placed 12 magnetometers in schools in 10 Northern states. This program is called the Geomagnetic Event Observation Network by Students (GEONS). As part of the GEONS program teachers were tasked with developing activities around the mission science and data from the ground-based research-quality magnetometers located at their schools. An activity by Petersburg, AK teacher Vic Trautman that has students determine daily average local magnetic field intensity was adapted for this project. Students would use Image J, a Java based public domain image processing software rather than making measurements of THEMIS magnetometer data plots by hand. The local magnetic field intensity data can then be examined by students to seek out patterns. Research can then be done to attempt to explain these patterns. This past summer research was done to determine what patterns might arise and how the students might be able to explain these results. Data on variations over time in the average daily solar proton (H+) density, velocity and IMF orientation of the solar wind were obtained from the Advanced Composition Explorer (ACE) spacecraft. These were plotted against daily average B (local magnetic field intensity) values calculated from data gathered from THEMIS E/PO ground station magnetometers located at 3 different locations - Carson City, Nevada; Loysburg, PA; and Remus, MI. Data were taken for periods of quiet geomagnetic. While no significant correlation was found between solar wind momentum and local B values in data having either a southward directed or a northward directed IMF, a seasonal oscillation in local magnetic field intensity was discovered in the data. A literature search confirmed that interaction between the tilt of Earth's dipole and IMF causes seasonal variations in local magnetic field intensity. Results showed the most obvious oscillation pattern in local B values at the lowest latitude - the Carson City, NV, site. Several classroom activities were designed around the completed research project. These activities will be used at Chippewa Hills High School to lay the foundation for a group of students to engage in an independent research project to be entered in the West Michigan Regional Science and Engineering Fair. A student project on changes in active region magnetic field activity as the result of X-class flaring was done last year as a result of teacher involvement in NOAO's Teacher Leaders in Research Based Science Education (TLRBSE) program, and student involvement in NOAO's Teacher Observing Program (TOP).
Finding Geomagnetic “Quiet” Days

Two methods were used to screen daily data. First, data with apparent man-made signals were discarded. Then data on days with lowest estimated Kp indices was selected for inclusion in the project.

The Excel plot of data from the study shows no correlation between daily average local magnetic field strength and daily average solar wind dynamic pressure.

Questions were raised by the outliers seen on the plot and the data was sorted by date and a new scatter plot made of field strength versus date. This seasonal oscillation in field strength is displayed in the plot to the right and highlights the interaction between the angle of Earth’s dipole field and solar wind.

It has been suggested that the interaction between these two parameters operate on a much shorter time interval. This will be the focus of a follow up study by students in Astronomy classes at CHHS.