

The Space Weather Underground Project

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SWUG Design

Our goal is to construct an array of fluxgate magnetometers across northern New England for the purpose of measuring transient ionospheric activity. With only 6 nodes active and 7 more nearing deployment, we see correlated time variability daily and transients at least weekly. Transient activity in clear response to the arrival of interplanetary shocks as recorded by the ACE spacecraft have been seen both with north-south and east-west ionospheric currents generally followed by multiple hours of variability. There is no doubt that the magnetometers are capable of performing the proposed research. In several events studied so far, patterns in arrival times at the various nodes are clearly resolved.

The mag technology is based on the SAM-III 3-axis fluxgate sold by Reeve Engineers in Anchorage Alaska.

Outdoor deployments, which are desired, incorporate photovoltaics and radio data link so that separation from buildings is relatively easy to accommodate.

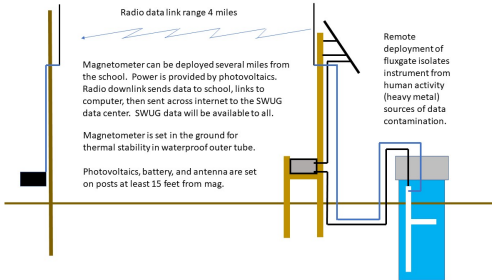
The radio data link is controlled by Arduinos.

Mags are deployed in the ground to maintain near-constant temperatures.

Each mag node costs approx. \$1100 including deployment hardware.

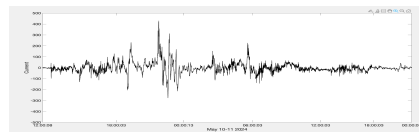
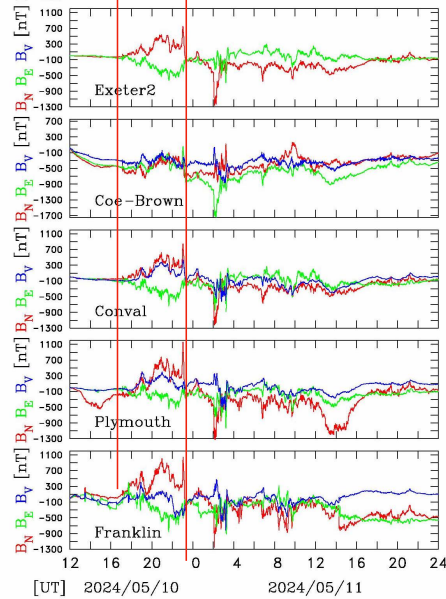
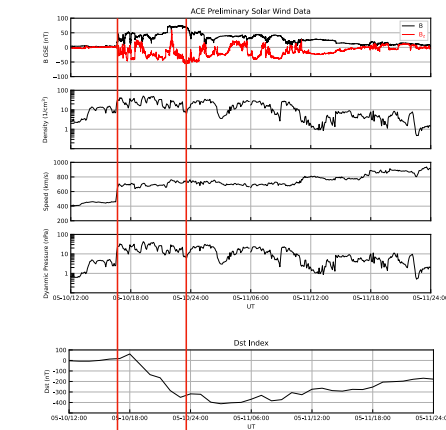
SAM-III provides 1 nT and 1 sec resolution, although we generally run at 2 sec resolution to obtain cleaner data.

Mags are calibrated on the benchtop prior to deployment and run as variometers. Absolute magnetic measurements are not promised.



School	City	Latitude	Longitude
Coe-Brown Academy	Northwood, NH	43.22	-71.21
CONVAL	Peterborough, NH	42.91	-71.94
Oyster River HS	Durham, NH	43.15	-70.94
Phillips-Exeter Academy	Exeter, NH	43.1	-70.92
Franklin Academy	Malone, NY	44.85	-74.29
Plymouth High School	Plymouth, NH	43.76	-71.69
Northeast Kingdom Astronomy Foundation	Peacham, VT		

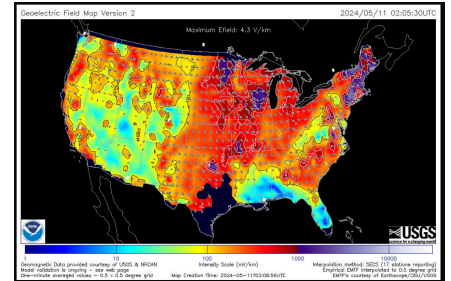
May 10, 2024 Storm



SWUG data from the May 10/11 storm, showing observations from 5 high school SWUG sites. The top 4 panels show solar wind magnetic fields, solar wind density, speed and dynamic pressure. The 5th panel shows Dst levels. Panels 6-10 show SWUG data from the various high schools. The variability in the observations is quite striking for such an arrangement of closely-space magnetometers

Although these are very low-cost instruments, their value in supporting regional studies (e.g., of GIC effects) appears to be very promising. The bottom panel shows a locally-observed GIC current in response to the storm.

Ground-induced currents

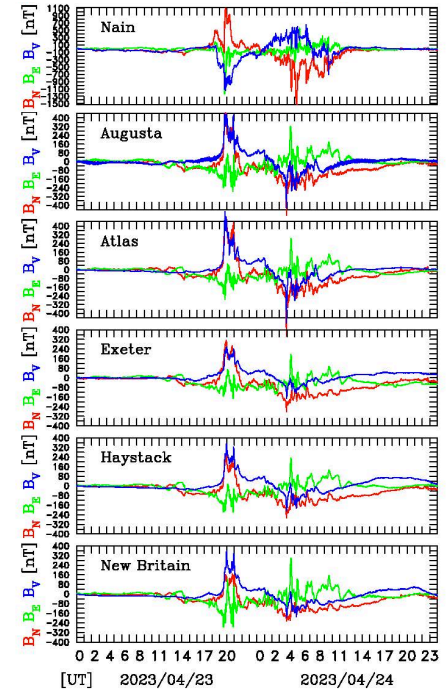


From spaceweather.com:

On May 10-11, geoelectric amplitudes exceeded 10 V/km in Virginia and 9 V/km in the upper Midwest," says Jeffrey Love, a key member of the collaboration at the USGS. "These are very high. For comparison, we estimate that geoelectric amplitudes reached almost 22 V/km in Virginia during the March 1989 storm."

Locally, GICs were measured to be 430 A at a substation located approximately 11 km from Phillips Exeter Academy. As can be seen from the map, the New England region appears to support strong GICs, perhaps related to a complex land/sea interface.

Collaborations w/MACCS and MAGSTAR arrays



During another strong event, we have been able to provide data that supports that of the MACCS and MAGSTAR arrays, further increasing the number of measurements being made across this extended region.

In this example, we show SWUG data from Exeter, NH, MACCS data from Nain, Newfoundland and MAGSTAR data from Augusta, ME, Haystack Obs in Westford, MA, Atlas, NY and New Britain, CT