HamSCI

Jerry Spring VE6TL – November 2025

Outline

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From left to right, Dr. Nathaniel Frissell (seated), Veronica Romanek, and Simal Sami in the ham radio station on the University of Scranton campus.

What is HamSCI?

Ham Radio **S**cience **C**itizen **I**nvestigation is a platform for the publicity and promotion of projects that are consistent with the following objectives:

- Advance scientific research and understanding through amateur radio activities.
- Encourage the development of new technologies to support this research.
- Provide educational opportunities for the amateur community and the general public.

HamSCI serves as a means for *fostering collaborations between professional researchers and amateur radio operators*. It assists in developing and maintaining standards and agreements between all people and organizations involved.

HamSCI's Focus:

HamSCI is mainly about radio wave propagation through the ionosphere as it was started by ham-scientists who study the upper atmosphere and space physics.

Science Questions:

- How does the ionosphere respond to inputs from space and from the neutral atmosphere?
- How does the ionosphere couple with the neutral atmosphere and with space?
- What are the sources of medium and large scale traveling ionospheric disturbances?
- What are the causes of Sporadic E?

Amateur Radio Questions:

- How do disturbances such as solar flares, geomagnetic storms, and traveling ionospheric disturbances affect radio wave propagation?
- How does ionospheric science help amateur radio operators improve communications?
- How can I use my existing radio equipment for scientific initiatives?

People:

Dr. Nathaniel A. Frissell, W2NAF
Lead HamSCI Organizer
The University of Scranton
Department of Physics and Engineering

Advisory Board

- Dr. Nathaniel Frissell, W2NAF, The University of Scranton, Chair
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- Dr. Ethan Miller, K8GU, STR
- Dr. Gareth Perry, KD2SAK, New Jersey Institute of Technology
- Mr. H. Ward Silver, N0AX, HamSCI Community
- Dr. Mary Lou West, KC2NMC, Montclair State University
- Dr. Christian Zorman, Case Western Reserve University

Membership is open by joining the HamSCI Google Group, which, as of mid-2025, numbered over 1,350 participants. HamSCI appreciates all of its members, their interest, their efforts and their contributions to HamSCI's mission.

HamSCI's Main Tools:

HamSCI loves BIG DATA. You can immediately help out by getting on the radio and making contacts – especially on CW or one of the digital modes. Your transmissions will add to the following databases:

- Reverse Beacon Network (RBN)
- WSPRNet
- PSKReporter

HamSCI's atmospheric and space scientists analyze the data and try to relate the quality and quantity of signals to what is happening in the ionosphere. This requires correlation with solar phenomena, such as CMEs, flares, coronal holes, etc. Ultimately, ham radio is helping scientists derive a better physical understanding of how the ionosphere works under a wide variety of conditions, often referred to as "space weather". This should lead to more reliable models and predictions of radio wave propagation.

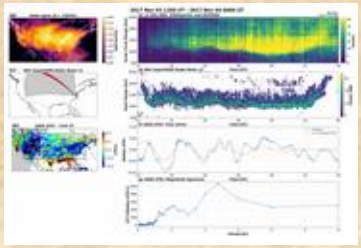
Active Projects:

Solar Eclipses 2023-2024

A series of ham radio experiments was conducted during these eclipses and the data are still be analyzed. The question: How do solar eclipses impact ionospheric structure and dynamics?

Personal Space Weather Station

The Personal Space Weather Station project ultimately aims to create a small, multi-instrument system that can make ground-based measurements of the space environment.



Sources and measurement of traveling ionospheric disturbances

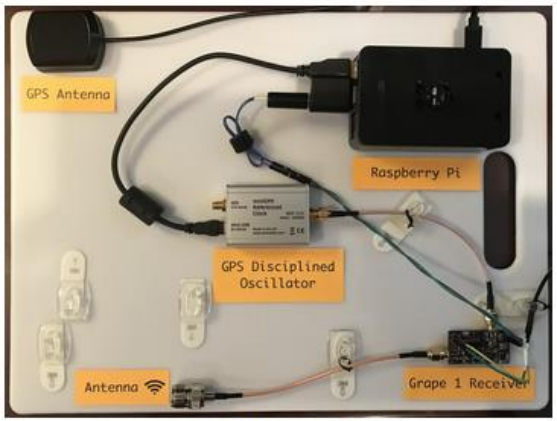
Traveling Ionospheric Disturbances (TIDs) are variations in the ionosphere that can impact medium frequency (MF) and high frequency (HF) radio communications through fading (QSB) and by causing variations in communications distance. In this project, we use data from large-scale amateur radio networks such as the Reverse Beacon Network, WSPRnet, and PSKReporter to study the sources, characteristics, and dynamics of TIDs.

Personal Space Weather Station:

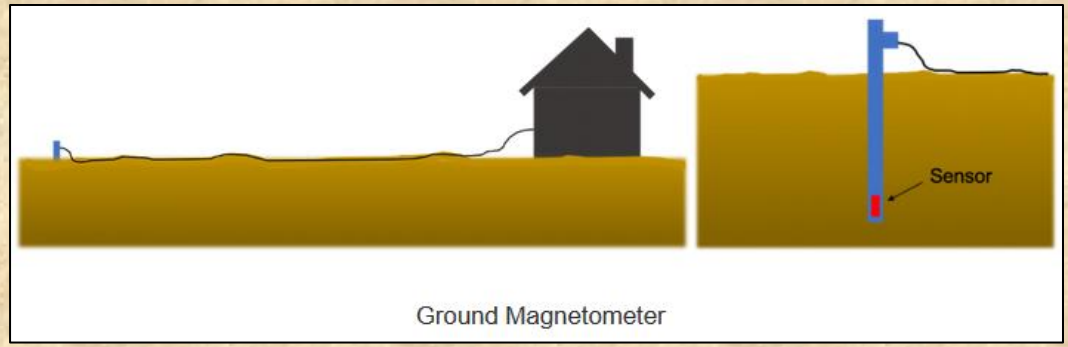
Goal: To create a geographically distributed, multi-instrument system capable of making ground-based measurements of the space environment. The measurements will aggregate into a central database for space science and weather research purposes.

As of mid-2024 there were numerous deployments of GRAPE* WWV Doppler Monitors, WSPR** receivers and ground magnetometers. The project is in collaboration with six distinct research groups, including MIT's Haystack Observatory and the Tucson Amateur Packet Radio, Inc (TAPR).

The most basic PSWS consists of a single module, such as a WWV Doppler monitor or a ground magnetometer. A VLF observatory is under development.



GRAPE 1 - fldigi



Ground Magnetometer

Grape Doppler Monitor

- **G**reat **R**adio **A**mateur **P**ropagation **E**xperiment
- HF Doppler receiver system – either single or multi-channel version, designed to monitor standard frequency stations simultaneously

- **Science Benefit:** Inexpensively achieve a distributed network of inexpensive receivers that provide spatial and temporal coverage of ionospheric changes, unattainable by just a few large observatories

- Monitor WWV, WWVH, CHU and measure small frequency changes over time (Doppler shifts)
- The monitored stations are stable on the order of 1 part in 10^13
- Changes in the ionosphere (primarily bottom side) affect path length and propagation characteristics of HF radio waves. These shifts are often associated with solar wx phenomena: flares, storms, eclipses or traveling ionospheric disturbances (TIDs).
- GRAPE receivers output continuous data of Doppler frequency vs time (and often amplitude) for the monitored beacons.

- **Host Station:** Typically Rpi 4, external HD, GPSDO (GPS disciplined oscillator), HF antenna, internet connection

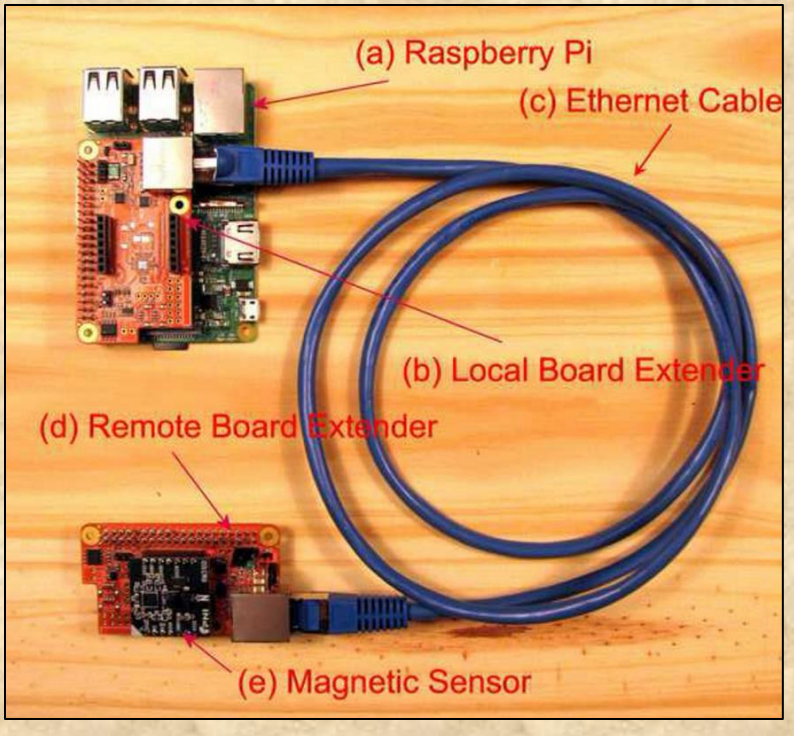
Grape 1 (Version 1.12)

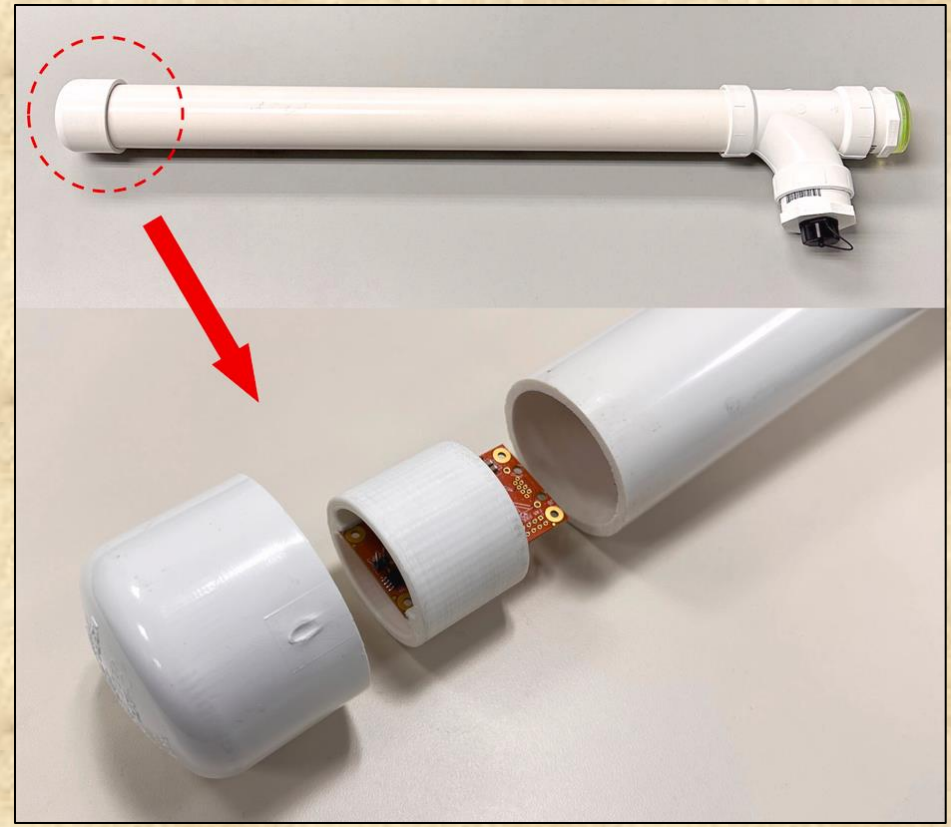
DIY single-frequency low-IF receiver

What is required:

- A custom PCB board ($7 + surface mount components $30) Components for that board (mixer, filters, etc.) via HamSCI
- (GPSDO) to provide a very stable local oscillator reference. Grape uses for example the Leo Bodnar Mini Precision GPSDO $150
- A Raspberry Pi computer (Pi 4 recommended $100 – with case) to run software (e.g., a modified version of fldigi) and data upload
- A USB audio interface / sound card (to capture the intermediate-frequency audio output - $8)
- 64 GB High-endurance MicroSD - $15
- HF antenna capable of receiving one of the time standard stations (e.g., WWV at 5 MHz, 10 MHz, etc.) – Cost not included.
- Reliable power supply, cabling, and an Internet connection (for daily uploads) and ideally continuous 24/7 uptime (to maximize scientific value). Cost not included.
- Suitable software image and configuration for data capture and upload.
- Total estimated cost: About $305 USD

Low Cost Magnetometer System





https://www.sciencedirect.com/science/article/pii/S2468067224000749

The primary **goals** are (1) to provide the general context of geomagnetic activity during the HF experiments proposed in the PSWS project; (2) to estimate ionospheric currents at mid/high latitudes; (3) to measure space weather-related disturbances (dB/dt) at higher latitudes.

Weekly Zoom

- Held every Thursday at 2pm local time (2000z)
- Participants include professional researchers, academics, students, citizen scientist volunteers
- Notifications go out to members via email

- I attended my first Zoom session on October 16, 2025
- Total 18 participants, including two from UK and two from Canada
- Topics included:
  - Meshtastic experimentation
  - PSWS Magnetometer readings
  - NASA Space Apps Contest – 2 day hackathon, > 8,000 teams worldwide (3 judges, one was in this Zoom call)
  - Astronomy (hunting for exoplanets, visiting observatories, etc.)

Publications:

HamSCI

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Publications

Author Title Type [**Year**

]

Export 527 results: **BibTeX RTF RIS**

2025

M. Lou West, Frissell, N., Mikitin, G., Popelas, G., Wilcox, R., Denton, M. K., Spalletta, R., Engelke, W., Griffiths, G., and Cerwin, S., **"Analysis by Citizen Scientists of Doppler Radio Observations of the April, 2024 Solar Eclipse"**, *HamSCI Workshop 2025*. HamSCI, Newark, NJ, 2025. **Google Scholar BibTeX RTF RIS**

A. Papadopoulos, Piccini, G., Frissell, N., Cerwin, S., McMahan, J., Bilberry, P., Samuel, B., Montaigne, A., Collins, K., and Spalletta, R., **"Analysis of the HamSCI Solar Eclipse High Frequency Time Difference of Arrival Experiment Observations Using Automated Techniques"**, *HamSCI Workshop 2025*. HamSCI, Newark, NJ, 2025. **Google Scholar BibTeX RTF RIS**

N. Hall-Patch, **"Approaches to Identifying Medium Wave Signal Enhancements in HamSCI's Solar Eclipse Data"**, *HamSCI Workshop 2025*. HamSCI, Newark, NJ, 2025. **Google Scholar BibTeX RTF RIS**

K. U. N. Baylor, Zhan, P., and Chen, B., **"Are Weak Type II Radio Bursts Associated with Shocks Driven by Coronal Mass Ejections?"**, *HamSCI Workshop 2025*. HamSCI, Newark, NJ, 2025. **Google Scholar BibTeX RTF RIS**

G. Zayed, Saeed, A., and Ismail, Y., **"Bridging Indoor RFID Localization and Long-Range Sensing: Exploring Energy-Efficient Backscatter Positioning"**, *HamSCI Workshop 2025*. HamSCI, Newark, NJ, 2025. **Google Scholar BibTeX RTF RIS**

D. Sanchez, Frissell, N., West, M. Lou, V. Harvey, L., Vadas, S., Becker, E., Perry, G., Engelke, W., Callahan, N., and Erickson, P., **"Climatology of Large-Scale Traveling Ionospheric Disturbances Observed with 14 MHz Amateur Radio Using a Novel Automated Detection Technique"**, *HamSCI Workshop 2025*. HamSCI, Newark, NJ, 2025. **Google Scholar BibTeX RTF RIS**

Plus Many More…

More Info:

https://hamsci.org/

https://science.nasa.gov/citizen-science/ham-radio-science-citizen-investigation/