

PSWS, HamSCI's Personal Space Weather Station: Hosts Wanted!

Gary Mikitin AF8A
Amateur Radio Community Coordinator
HamSCI Community

HamCon Colorado®
October 23, 2025

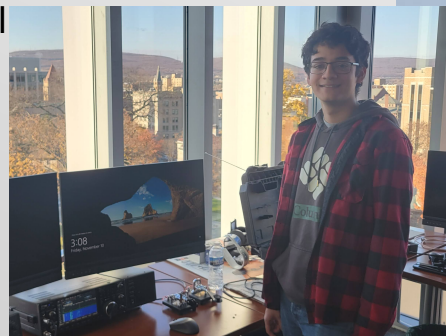
What is Amateur (Ham) Radio?

- **Hobby for Radio Enthusiasts**
 - Communicators
 - Builders
 - Experimenters
- **Wide-reaching Demographic**
 - All ages & walks of life
 - Over 760,000 US hams; ~3 million Worldwide
- **Licensed by the Federal Government**
 - Basic RF Electrical Engineering Knowledge
 - Provides a path to learning
 - Licensing ensures a basic interest and knowledge level from each participant
 - Each ham has a government-issued call sign
- **No License Needed for Receiving (SWLs)**



University of Scranton
Students KC3UAW and
KD2UHN with W2NAF
at W3USR

New ARDC-Funded
W3USR HF Antennas



KD2ZHK @ the
New ARDC-Funded
W3USR Scranton
Station

HamSCI Ham radio Science Citizen Investigation



HamSCI at 2023 Dayton Hamvention



Founder/Lead HamSCI Organizer:
Dr. Nathaniel A. Frissell, W2NAF
The University of Scranton

A collective that allows university researchers to collaborate with the amateur radio community in scientific investigations.

Objectives:

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

HamSCI's Primary Interest: The Ionosphere

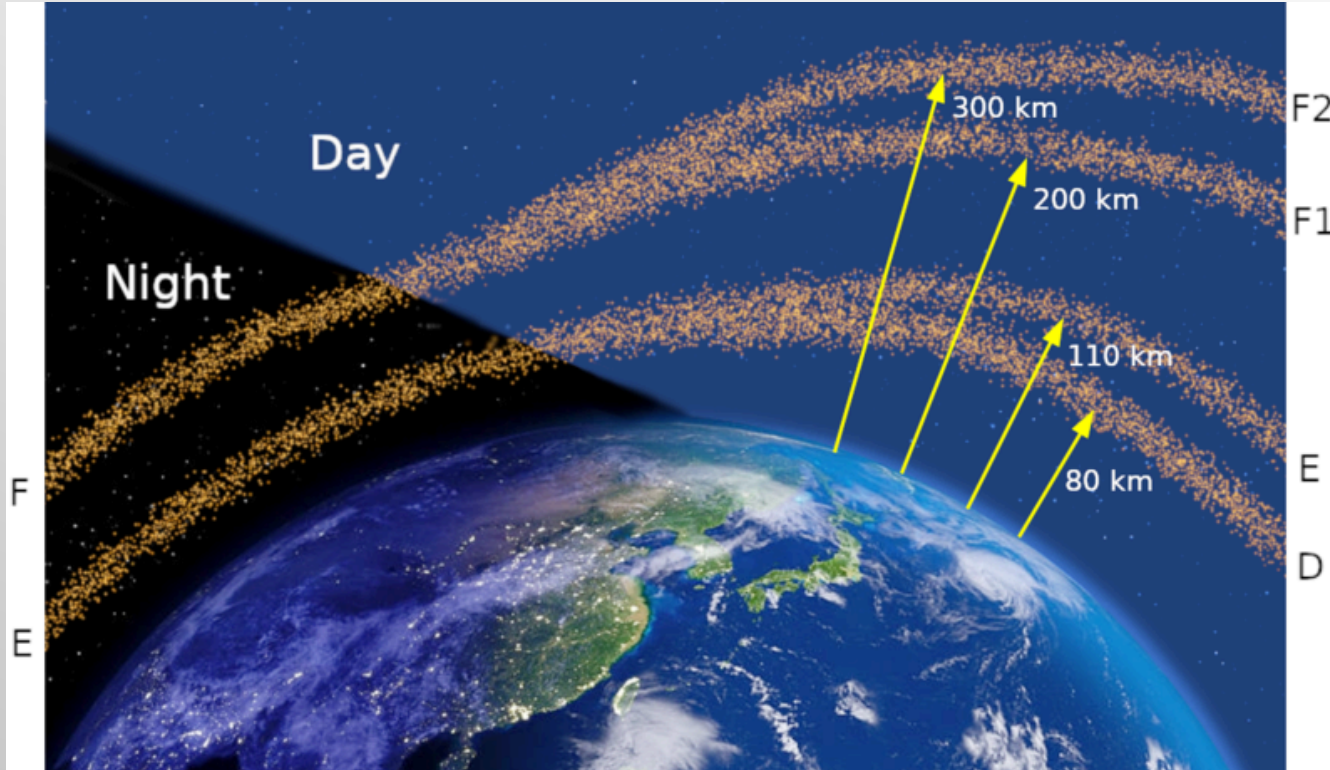


Figure by Carlos Molina (<https://commons.wikimedia.org/wiki/>)

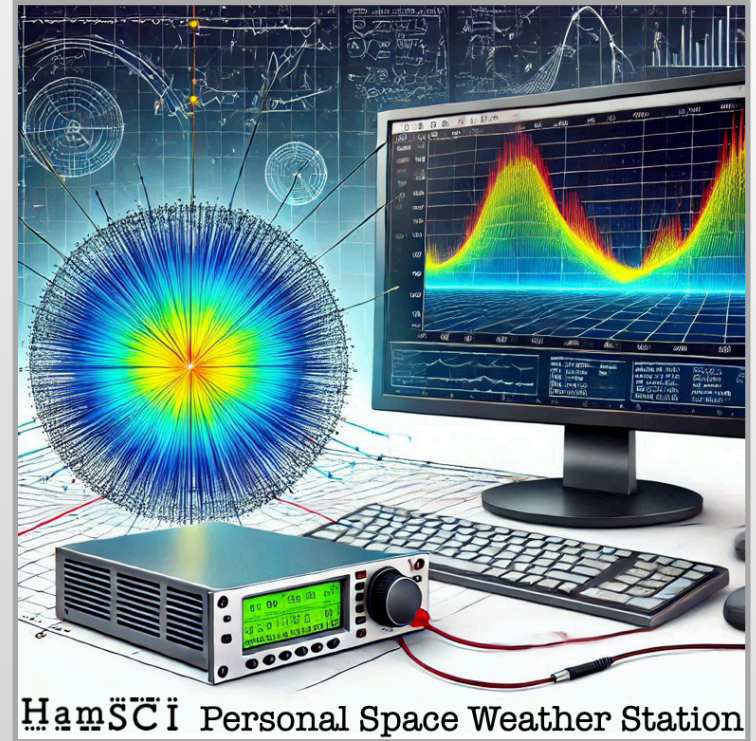
HamSCI PSWS Network: What, Why, How

- ◆ What is the PSWS Network?
- ◆ Why build (or expand) such a network?
- ◆ How can hams (and SWLs) participate?

HamSCI PSWS Network: Definition

The HamSCI Personal Space Weather Station (PSWS) Network is a Distributed Array of Small Instruments (DASI*)

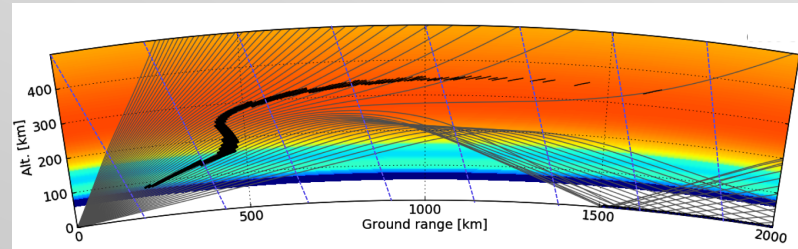
*NSF Funding Program 24-538 announced February 9, 2024



HamSCI PSWS Network: What and Why

What it is: An interconnected system of instruments, making frequent measurements across a wide geographic area

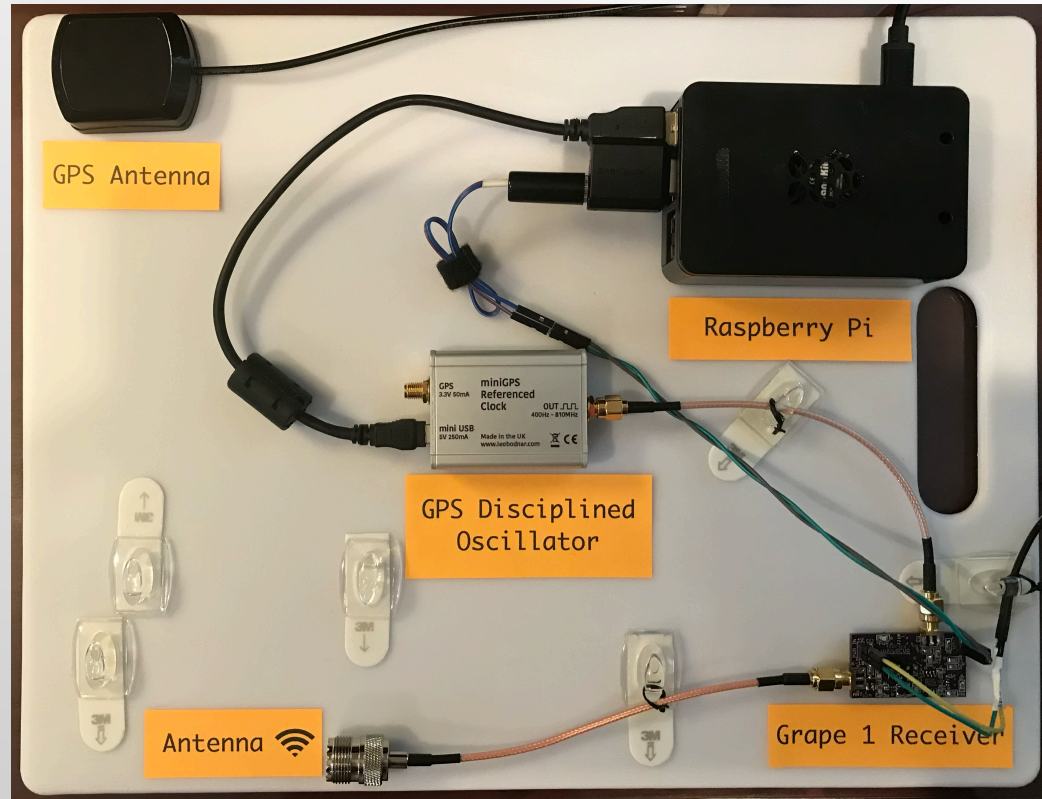
Why build it: The network will help in understanding the local, regional, and global scale processes that are essential for addressing fundamental questions in solar and space physics.



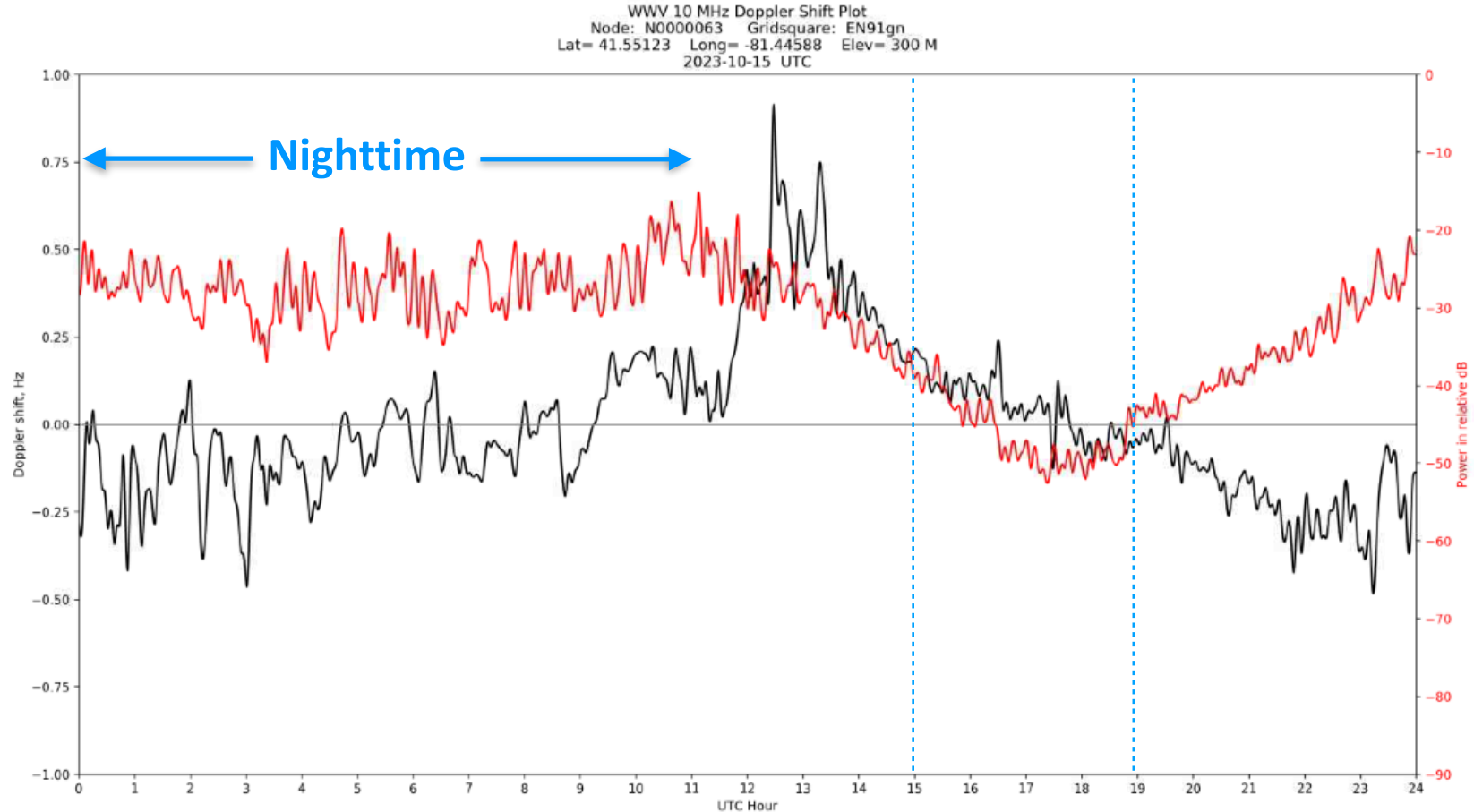
History Lesson: HamSCI's GRAPE Network

HamSCI, through its volunteers and participating institutions, designed and deployed the GRAPE* series of instruments prior to the North American solar eclipses in 2023/24.

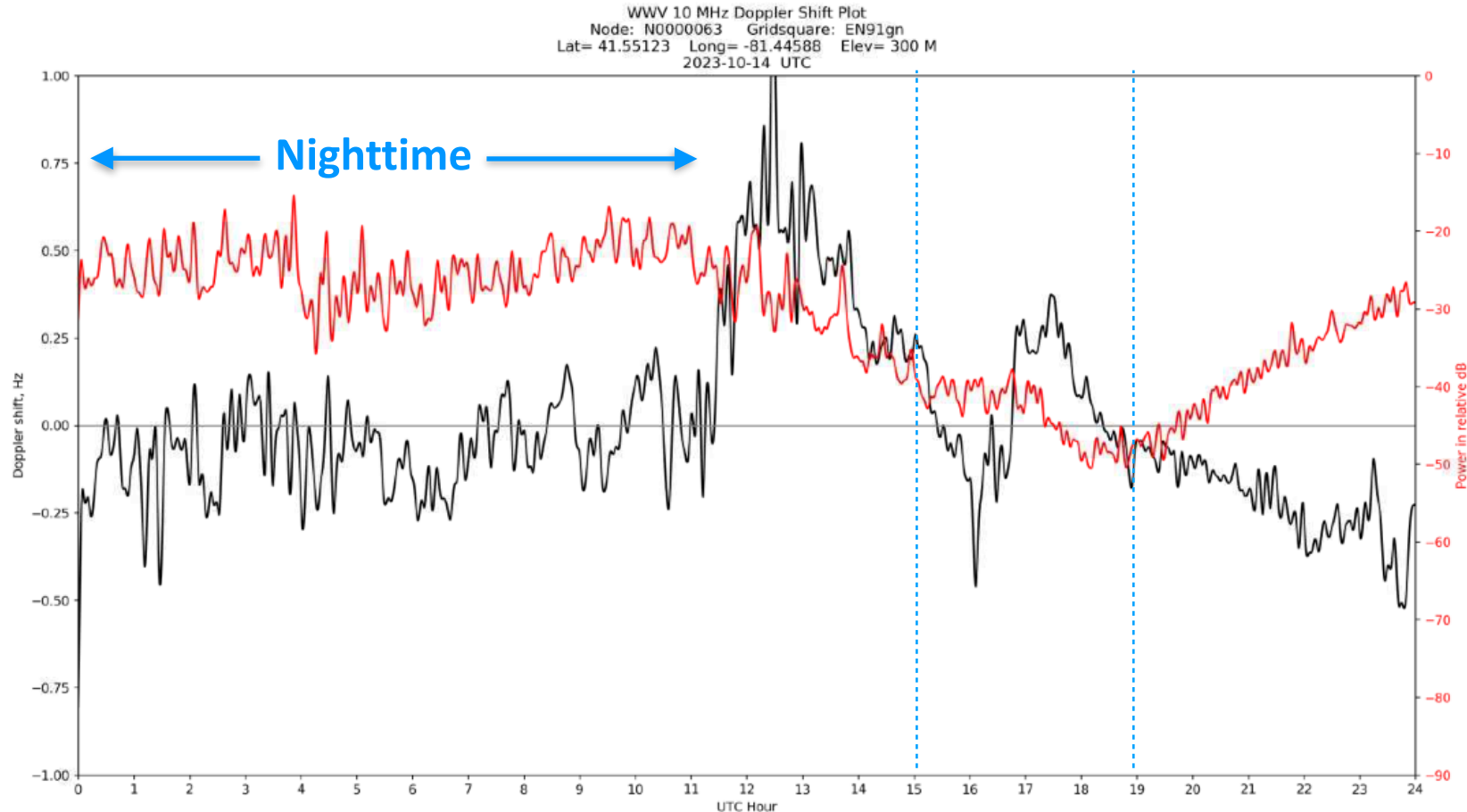
*GRAPE = Great Radio Amateur Propagation Experiment



GRAPE Doppler Plot - Quiet Solar Conditions



GRAPE Doppler Plot - Annular Eclipse Day, 14 October 2023



HamSCI PSWS Network

Definition: An interconnected system of instruments, making frequent measurements across a wide geographic area

Goal: Determine the local, regional, and global scale processes that are essential for addressing the fundamental questions in solar and space physics - including radio wave propagation

PSWS Network: Frequent Measurements

HamSCI's current GRAPE* instruments are operating 24/7/365, creating, at a minimum, one data point *per second*, *per instrument*

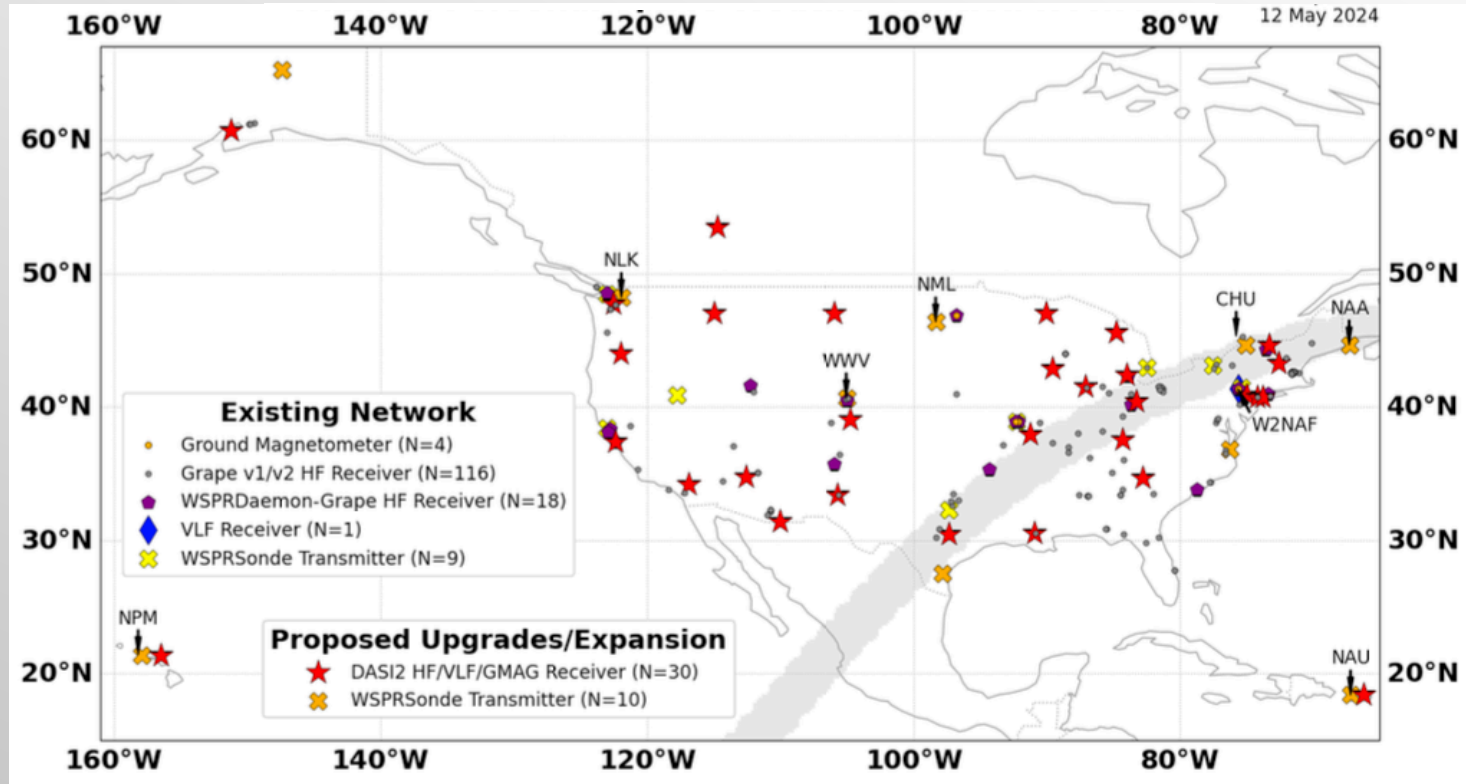
The future PSWS instruments will operate similarly - monitoring, collecting, uploading data to a central server

*GRAPE = Great Radio Amateur Propagation Experiment

To learn more about GRAPEs, visit hamsci.org/psws

# Station Node Number	N0000063			
# Callsign	AF8A			
# Grid Square	EN91gn			
# Lat Long Elev	41.55123 -81.4588 300			
# City State	Mayfield Village OH			
# Radio1ID	Grape_Gen_1_Rcvr_1			
# Antenna	Chameleon RXL Loop			
# Frequency Standard	LB GPSDO			
# System Info	RasPi4B			
# Beacon Now Decoded	WWV10			
UTC	Freq	Freq Err	Vpk	dBV(Vpk)
2025-01-31T00:00:00Z	9999999.789	-0.211	0.027568	-31.19
2025-01-31T00:00:01Z	9999999.995	-0.005	0.033579	-29.48
2025-01-31T00:00:02Z	10000000.007	0.007	0.038137	-28.37
2025-01-31T00:00:03Z	9999999.920	-0.080	0.045220	-26.89
2025-01-31T00:00:04Z	9999999.845	-0.155	0.045637	-26.81
2025-01-31T00:00:06Z	9999999.603	-0.397	0.037036	-28.63
2025-01-31T00:00:07Z	9999999.535	-0.465	0.032896	-29.66
2025-01-31T00:00:08Z	9999999.570	-0.430	0.031376	-30.07
2025-01-31T00:00:09Z	9999999.604	-0.396	0.034110	-29.34
2025-01-31T00:00:10Z	9999999.838	-0.162	0.036455	-28.76

PSWS Network: Wide Geographic Coverage



Expanded PSWS Network: Key Elements

Rx Hardware: Three Instruments

- Wideband HF SDR, VLF Receiving Apparatus, Ground Magnetometer

Tx Hardware

- WSPRSonde 8-band WSPR/FST4W GPS disciplined transmitter

Host Locations

- Rx: Co-Located Hardware: HF+VLF+Magnetometer
- Rx: A Suitable Electromagnetic Environment (ie RF quiet)
- Rx: Reliable Internet
- Tx: Multi-band antenna(s), 80-6 meters
- Reliable power

PSWS Network: Critical Elements

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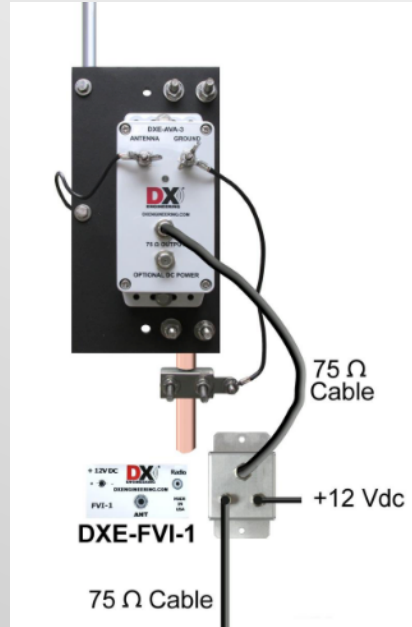
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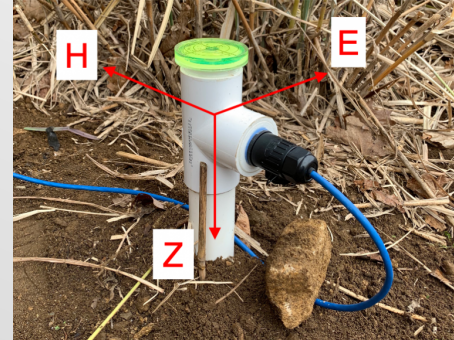
PSWS Network: Rx Hardware



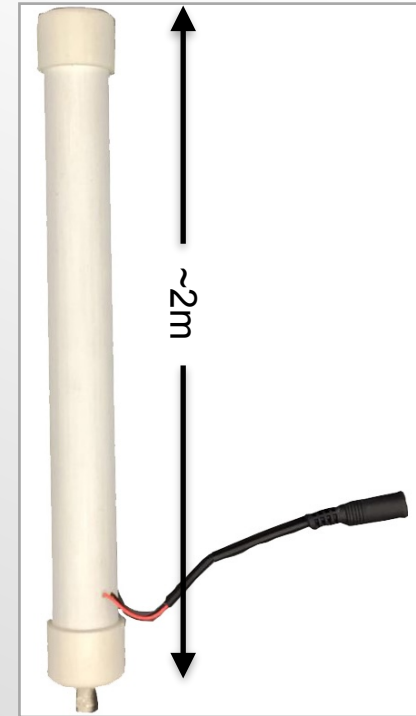
WSPRDaemon Grape
Based on RX888 SDR



Active HF Antenna



Ground Magnetometer



Active VLF Antenna
+ VLF rx equipment

Images for discussion purposes only - not to scale - actual hardware may be quite different!

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Rx Site Selection Challenge

Herein lies the challenge, finding sites which are...

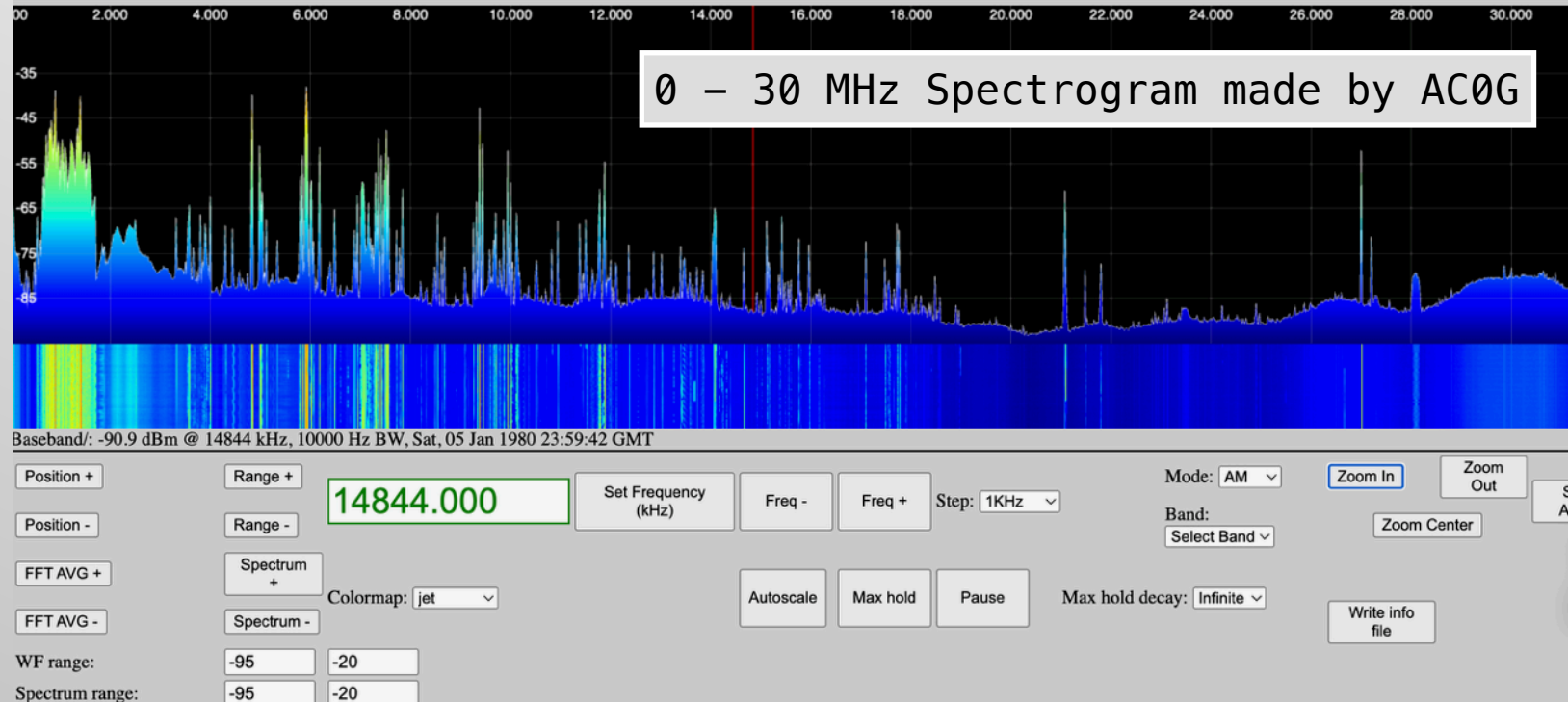
... 'RF Quiet' - on the HF bands. This means minimal noise sources (EMI, powerful local transmitters, mixing products)

... 'open field' sites for the VLF antenna - with significant separation from sources of mains harmonics

... able to bury a ground magnetometer, location free from electromagnetic influences (current carrying conductors, vehicles, etc.)

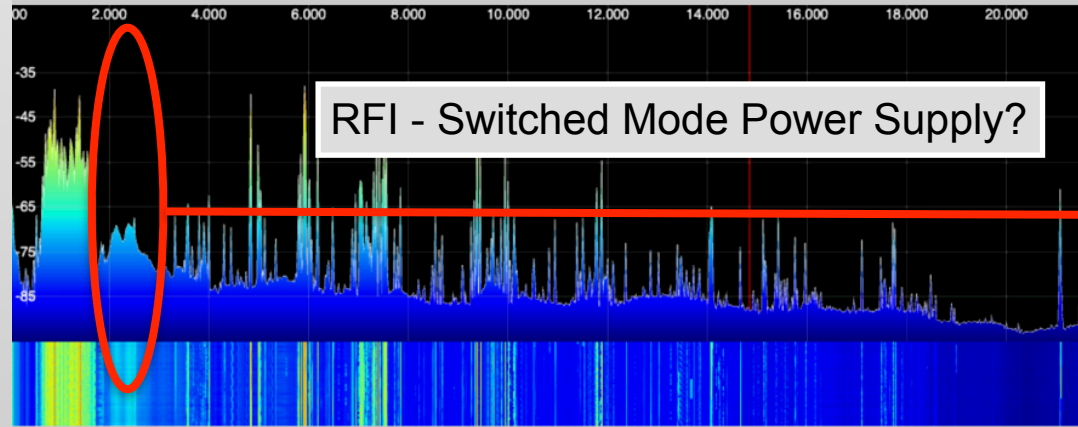
PSWS Sites: HF Spectrum Analysis

AC0G @EM38ww N6GN SAS1



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AC0G @EM38ww N6GN SAS1



RFI - Switched Mode Power Supply?

Baseband/-90.9 dBm @ 14844 kHz, 10000 Hz BW, Sat, 05 Jan 1980 23:59:42 GMT

Position + Range + 14844.000 Set Frequency (kHz) Freq - Freq + Step: 1KHz

Position - Range -

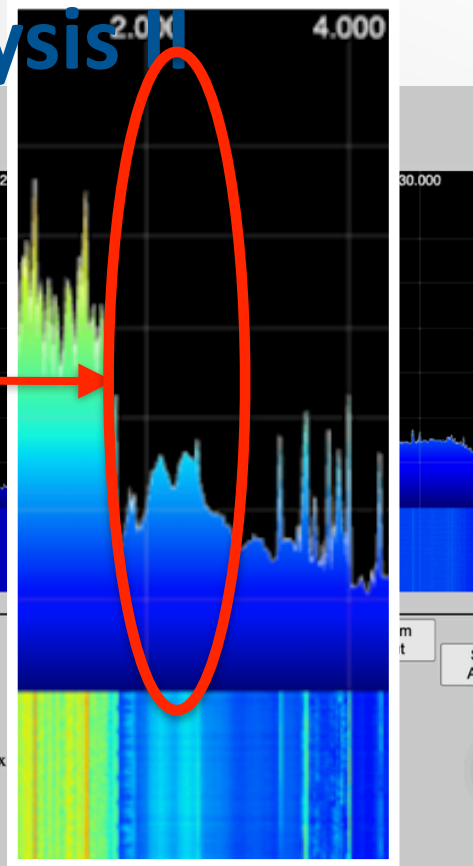
FFT AVG + Spectrum + Colormap: jet

FFT AVG - Spectrum -

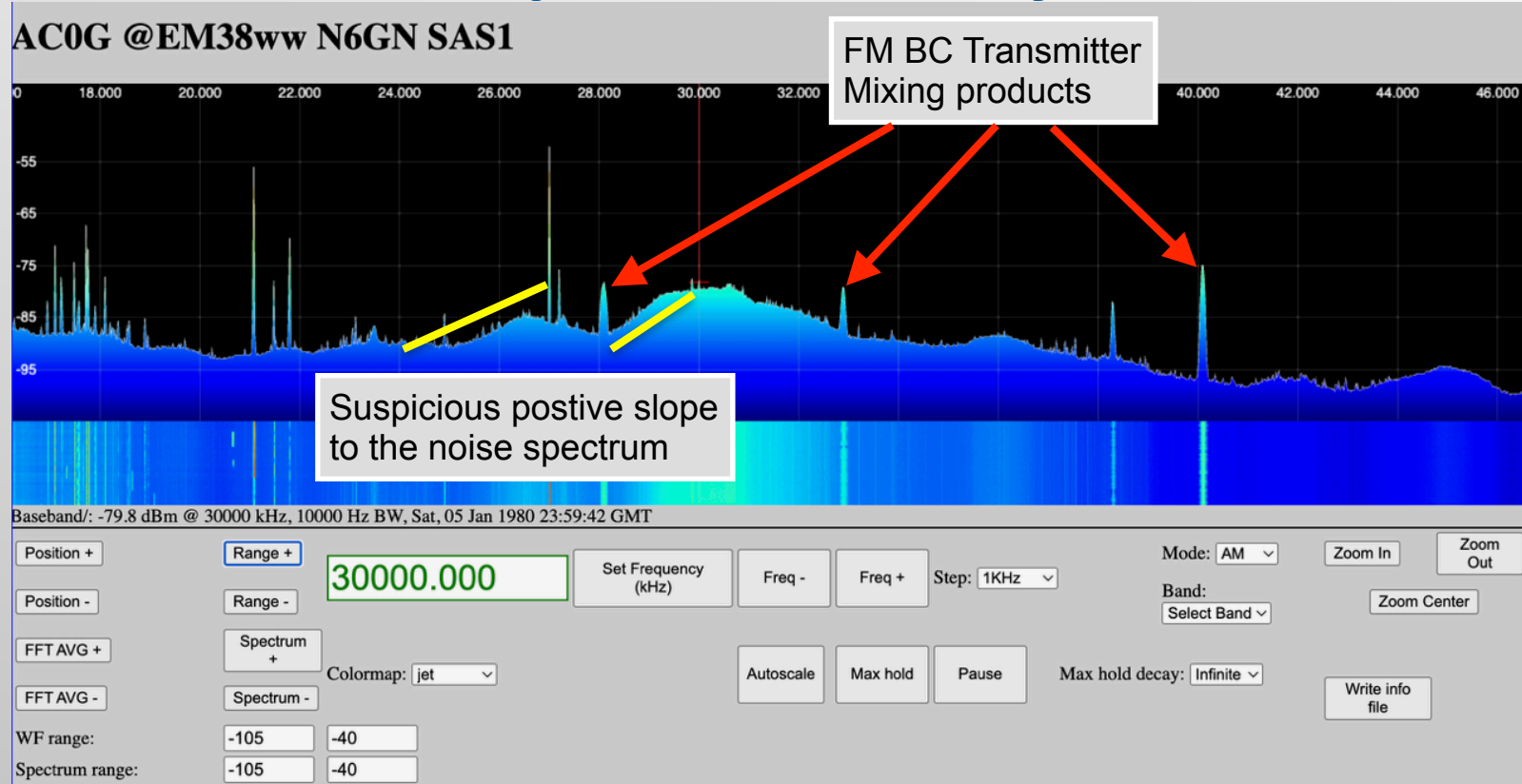
WF range: -95 -20

Spectrum range: -95 -20

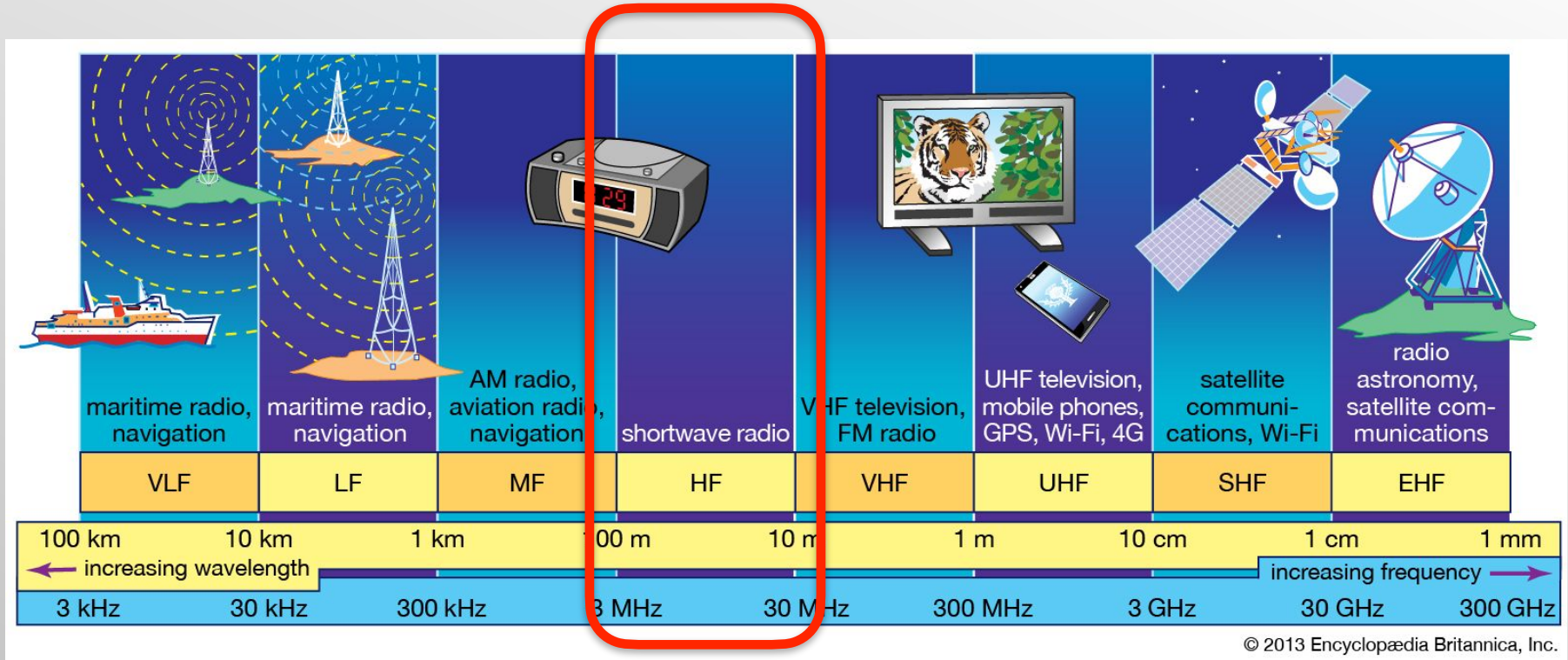
Autoscale Max hold Pause



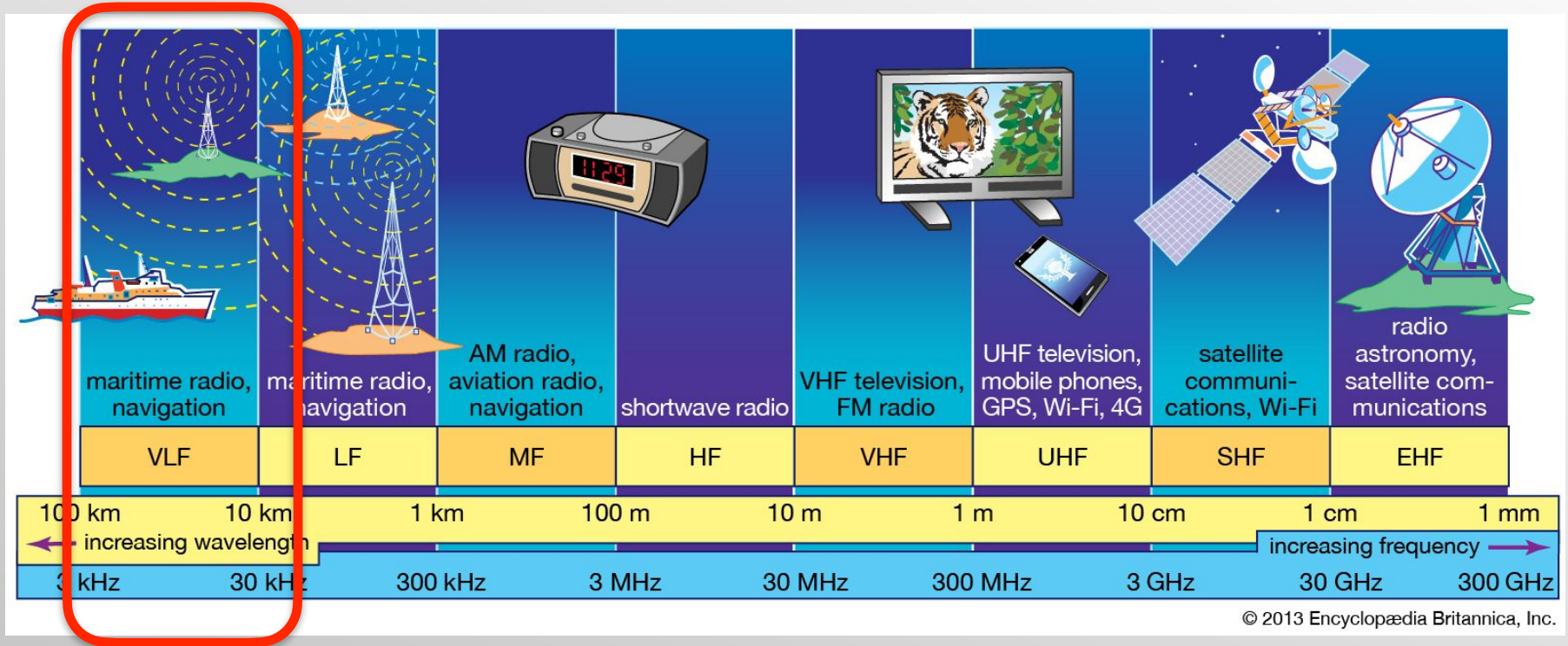
PSWS Sites: HF Spectrum Analysis



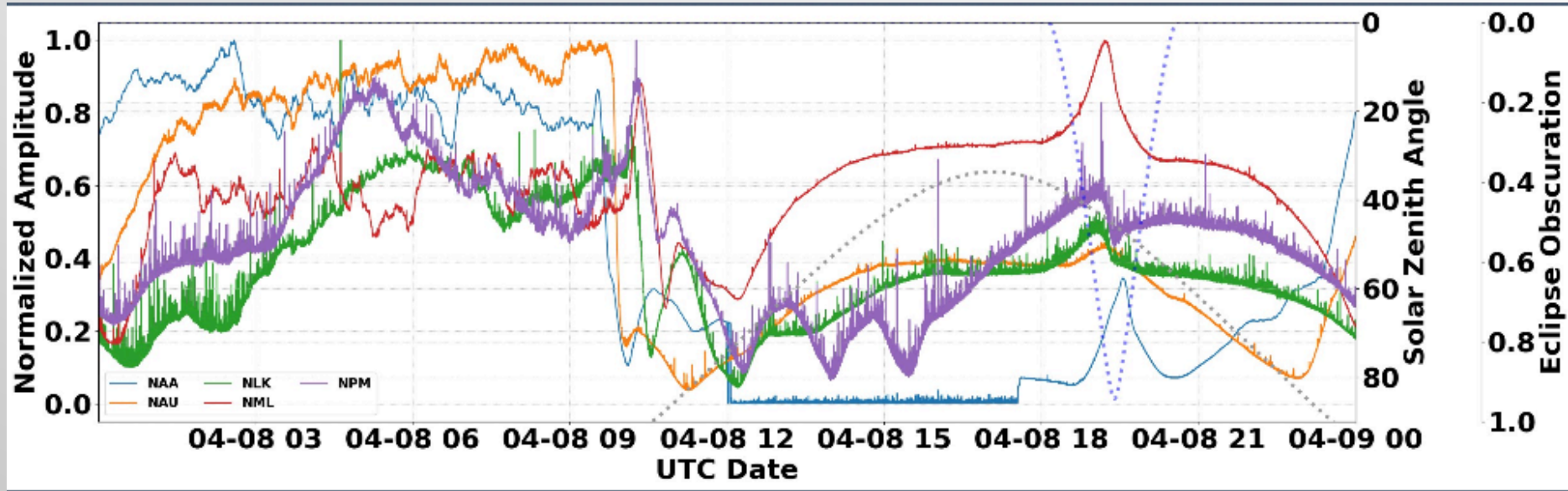
PSWS Interest: HF Bands, 1.8 - 52 MHz



PSWS Interest: VLF Band, 3-50 kHz

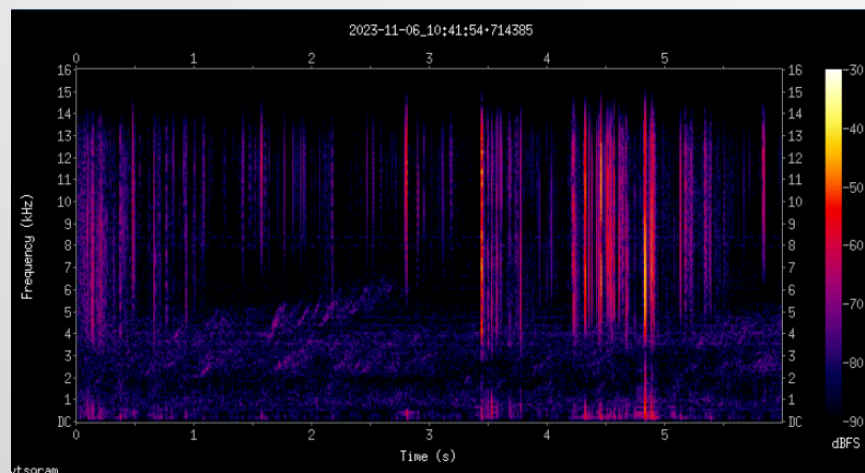
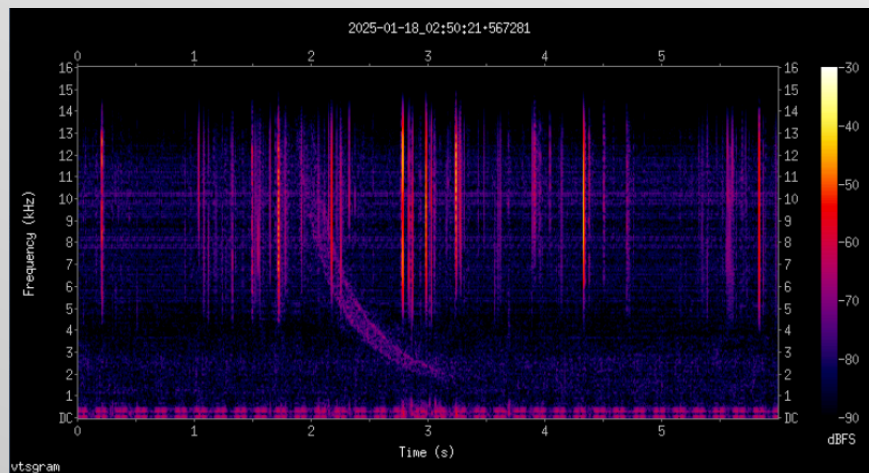


PSWS Sites: VLF Observations (3-50 kHz)



Apr 8, 2024 VLF Reception (by Jonathan Rizzo, KC3EEY, Scranton, PA)

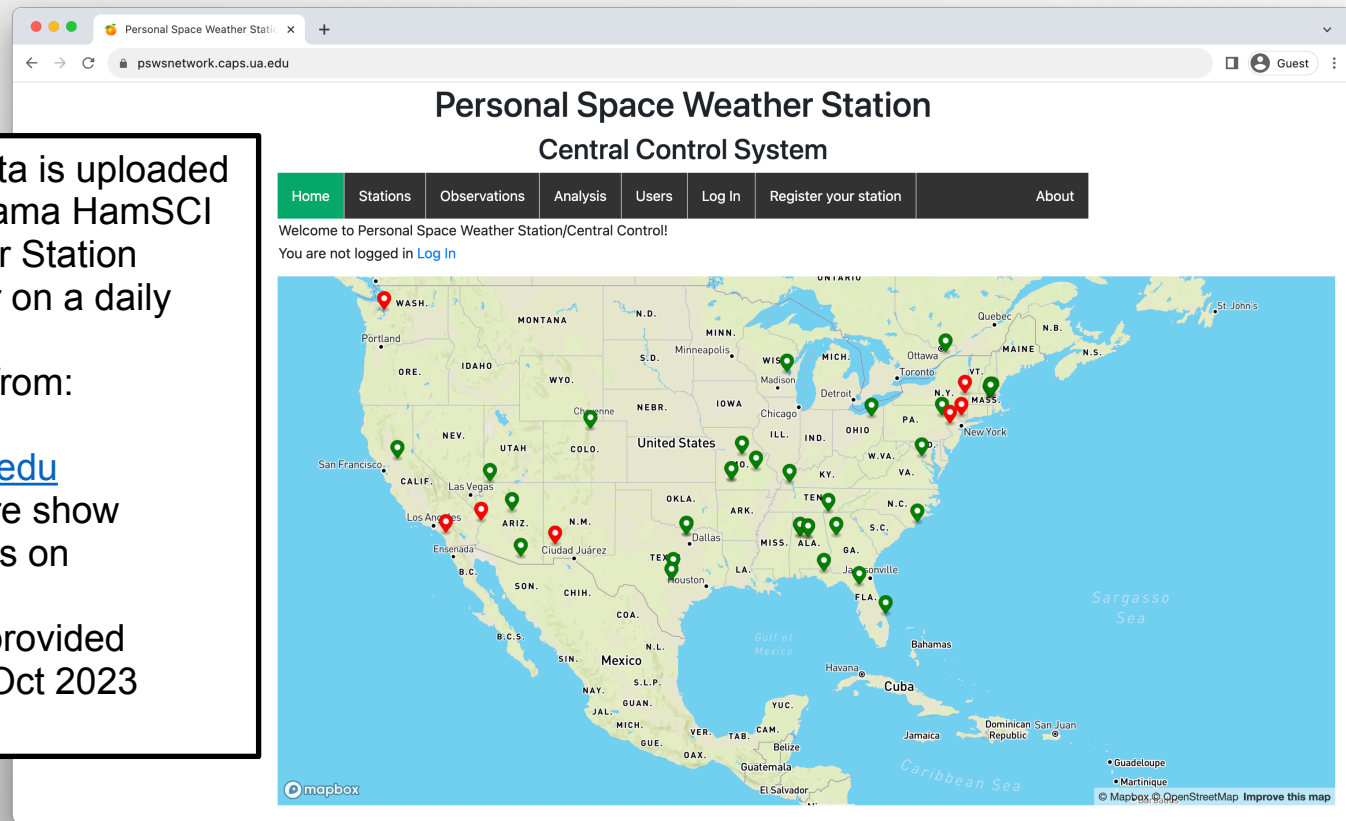
VLF Whistlers and Dawn Chorus Reception



Nov 6, 2024 VLF Reception (by Jonathan Rizzo, KC3EEY, Scranton, PA)

HamSCI PSWS Central Website

- All Grape1-DigitalRF Data is uploaded to the University of Alabama HamSCI Personal Space Weather Station Central Database server on a daily basis.
- Database is accessible from:
- psws.hamsci.org
- pswsnetwork.eng.ua.edu
- Green points in this figure show actively reporting stations on 12 Dec 2023
- Over 30 Grape1-DRFs provided observations for the 14 Oct 2023 annular eclipse



PSWS Network: Critical Elements

Rx Hardware: Three Instruments

- Wideband HF SDR, VLF Receiving Apparatus, Ground Magnetometer

Tx Hardware

- WSPRSonde 8-band, GPS-disciplined transmitter

Host Locations

- Rx: Co-Located Hardware: HF+VLF+Magnetometer
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TX Hardware: WSPRSonde 8

Simultaneous 8-channel WSPR and FST4W transmitter, 0-1 watt per-channel output. Extreme frequency accuracy and stability for precision propagation research.

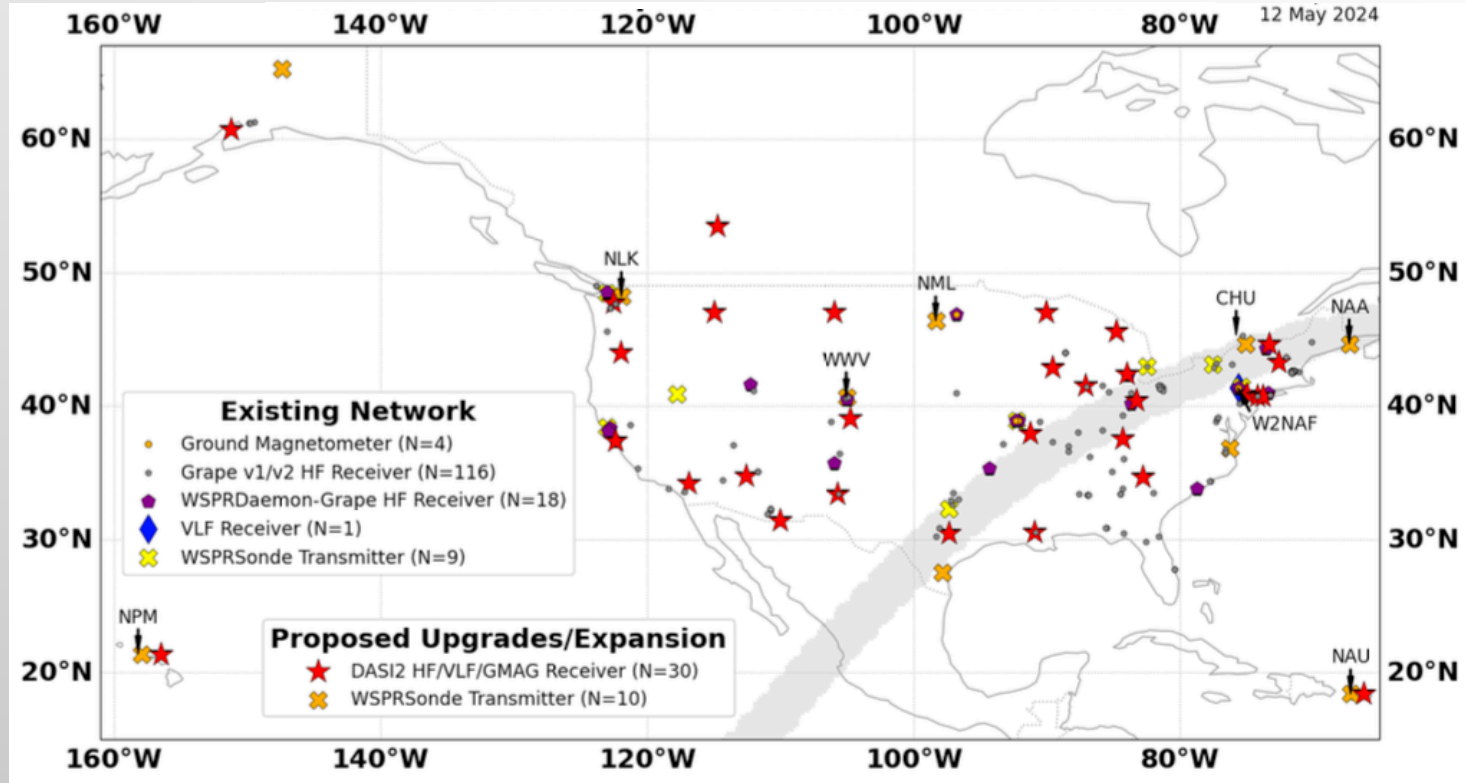


Available from Turn Island Systems (state of WA)

HamSCI is Asking for *Your* Support

We are looking to fill out this map. Hosts and sites are needed across the US

Deployments will be phased in over the next 6-24 months



Intellectual Merit

This project will establish the only wide-spread, coordinated HF, VLF, and ground magnetometer measurements distributed primarily across the midlatitude region.

Once deployed, this enhanced PSWS network will enable researchers to investigate both local and continental space effects, including those caused by traveling ionospheric geomagnetic storms.

Continued support of the network will enable the ongoing collection of a dataset spanning the peak years of Solar Cycle 25, and support future studies of long-term climatology.

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The Ionosphere Deserves Continued Study

HamSCI sponsored many events during the past seven years, and though they generated terrabytes worth of data, by no means are we 'done'.

- The Sun throws off flares and ejects huge masses of plasma towards Earth, impacting the ionosphere - there are many more solar events in our future
- The Earth itself generates interesting phenomena, such as TIDs
- GPS signals pass through the ionosphere.
- Starlink and other Internet constellations pass signals through the ionosphere.
- Shortwave radio is not 'dead'. Ask the military or the high frequency traders who covet our HF allocations



How Can You Participate?

- Visit the HamSCI Booth on Friday, Saturday or Sunday
- Join HamSCI's Google Groups attend our weekly Zoom telecons
- Some may wish to self-fund (always appreciated!)
- NSF grants may cover hardware costs for a limited number of stations (both Rx and Tx)

3 WSPRDaemon Grape
Receivers at W2NAF



Questions and Sign-Up

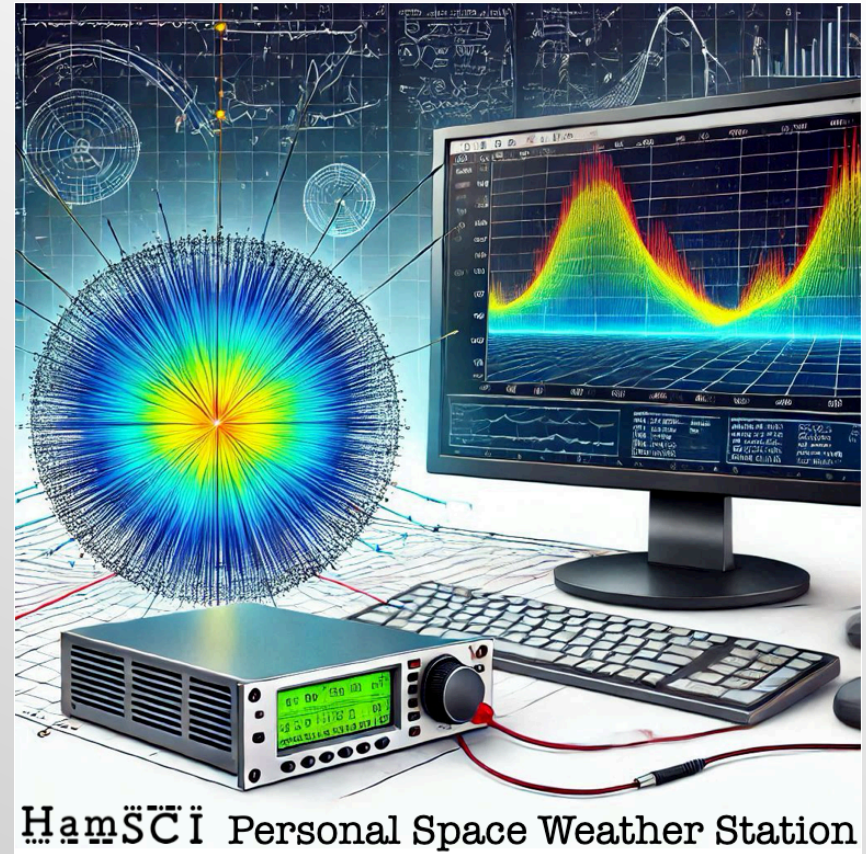
Sign up to our list of interested hosts:

hamsci.org/site-search



Questions:

hamsci@hamsci.org



HamSCI Personal Space Weather Station

DASI2: NSF HamSCI Grantees, 2025-2028



NSF Grants 2432821, 2432822, 2432823, 283824

Cycle 25 - Feel the Excitement!

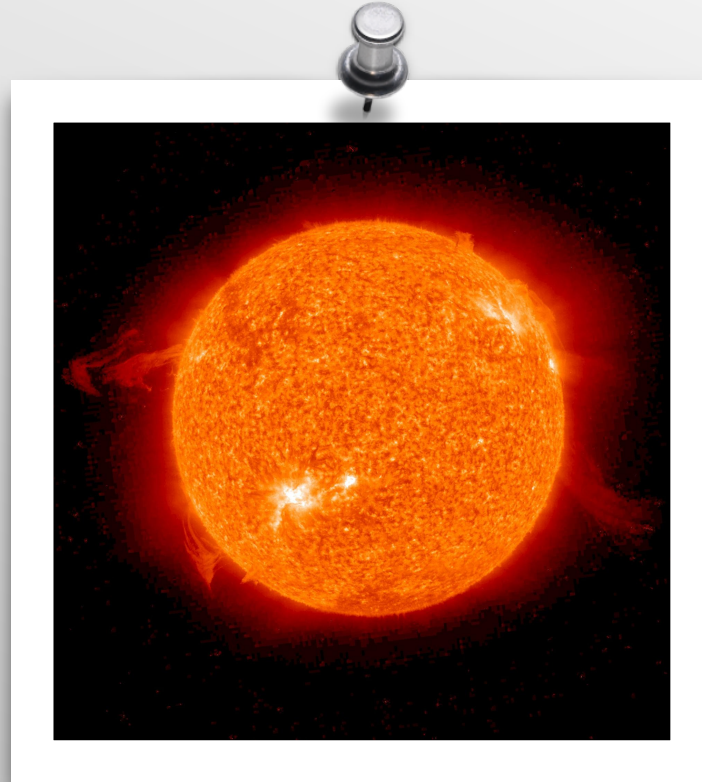
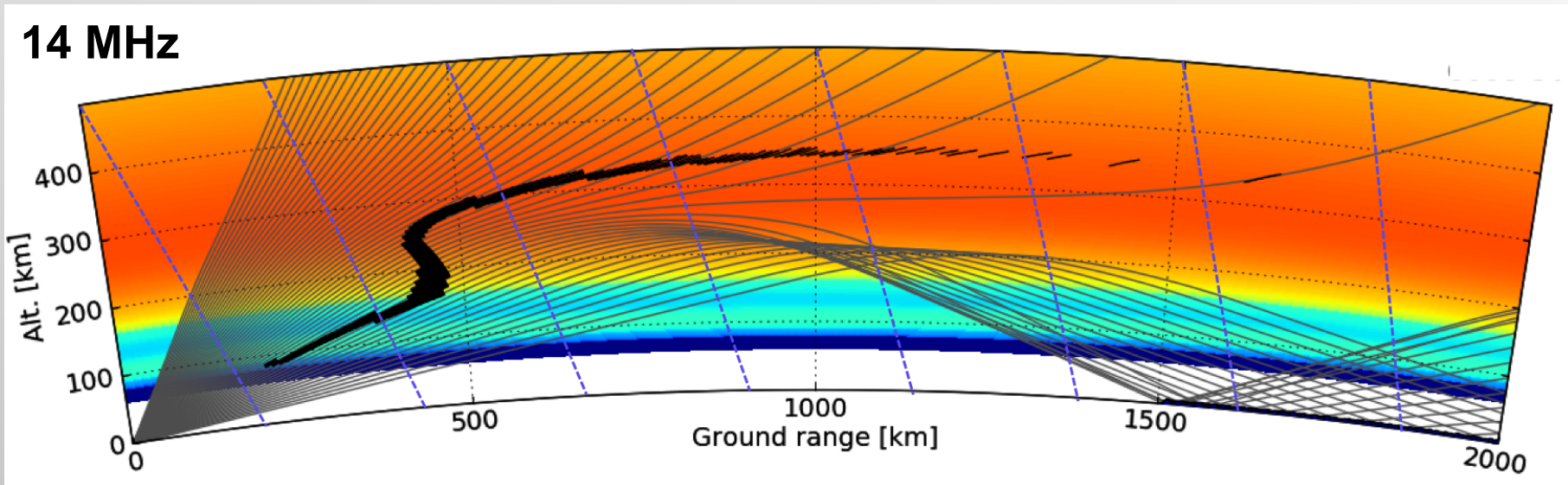


Image: NASA SOHO via GSFC

Ionospheric Modeling - Theory vs Practice



PHaRLAP Raytrace by W2NAF