HamSCI: Today's Community and Future Directions

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ARRL/TAPR DCC
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HamSCI Ham radio Science Citizen Investigation

hamsci.org/dayton2017

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:

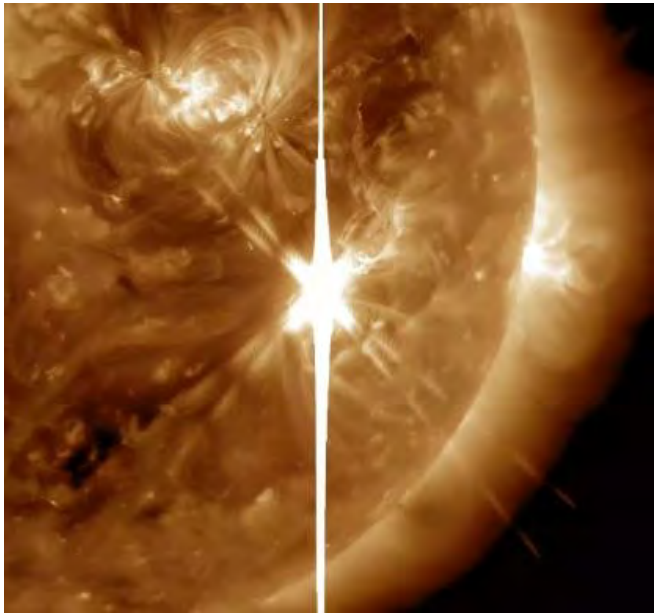
1. **Advance** scientific research and understanding through amateur radio activities.
2. **Encourage** the development of new technologies to support this research.
3. **Provide** educational opportunities for the amateur radio community and the general public.

Large citizen science community organized through e-mail lists, regular telecons, and the annual HamSCI workshop. See https://hamsci.org/get-involved.

What are the science goals we are after?

Broadly, we are interested in any scientific question of interest to the amateur radio community or to the field of space physics. Examples include:

- Solar Flare Impacts
- Geomagnetic/Ionospheric Storms
- Internal Ionospheric Electrodynamics
- Short time scale/small spatial scale ionospheric variability
- Connections with Lower Atmosphere



NASA SDO Observation of X9.3 Solar Flare on Sept 6, 2017. Flares such as this one can cause HF radio blackouts.

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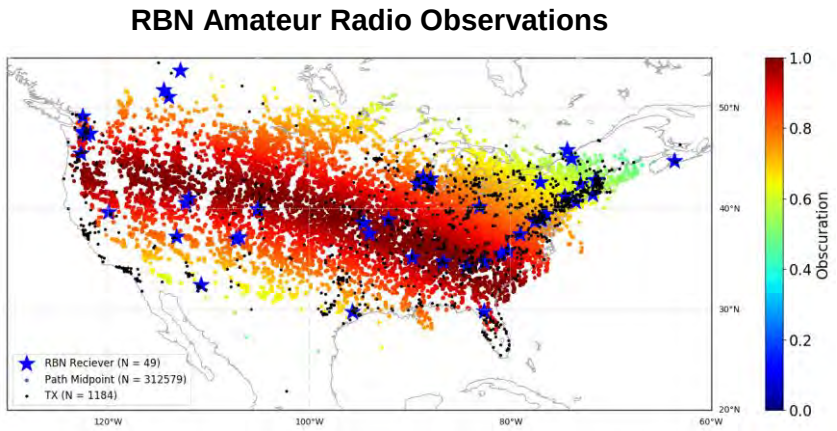
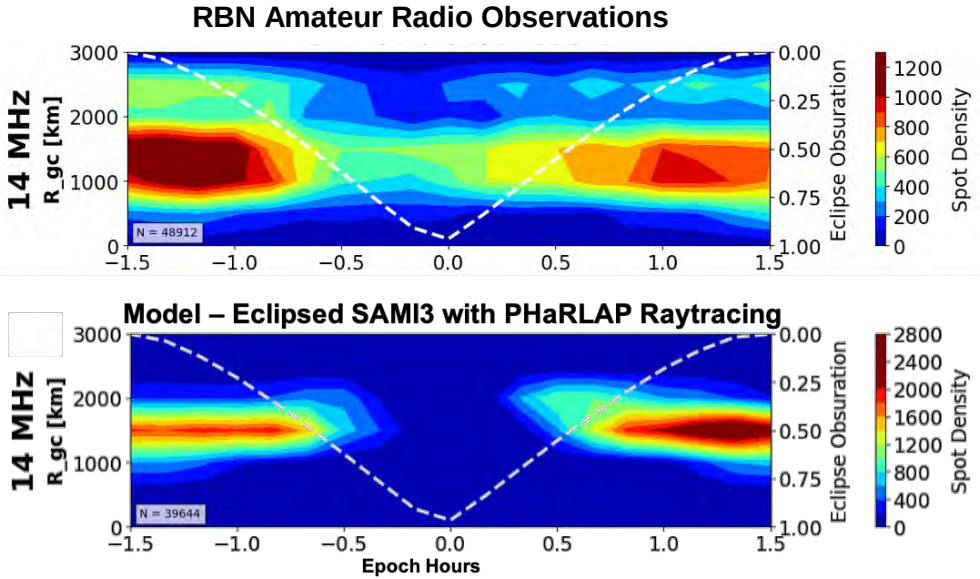
2017 Solar Eclipse QSO Party





[Frissell et al., 2018, https://doi.org/10.1029/2018GL077324]

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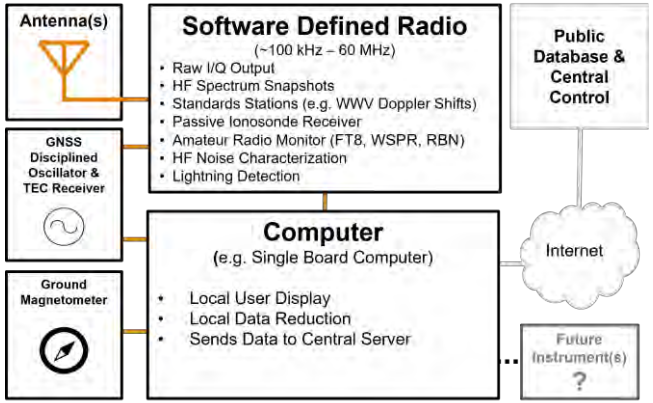
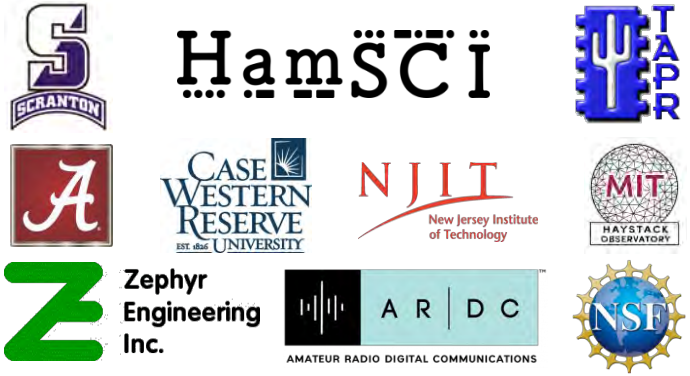
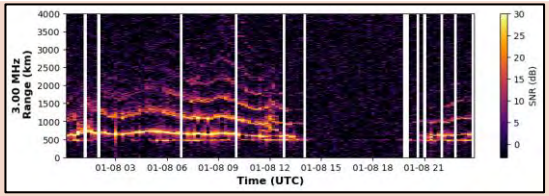
Personal Space Weather Station





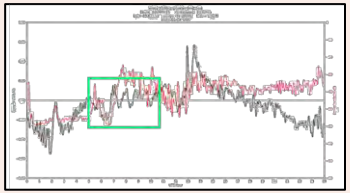
TangerineSDR

WA2DFI, N5EG, N8UR, KV0S, AB4EJ, N1HAC, AA8K, N4XWE, W2NAF, KC3PVE, W1PJE, Juha Vierinen, et al.



Grape PSWS

KD8OXT, AD8Y, N8OBJ, KB3UMD, WA5FRF, KD2UHN, NQ6Z, AB4EJ, W2NAF, K4BSE, KD8CGH, W7LUX, KE8QEP, et al.

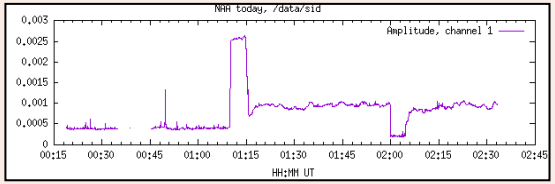


Magnetometer Module

KD0EAG, K2KGJ, KD2MCR, KE8QEP, WA2DFI, KV0S, W2NAF, et al.

VLF RX

KC3EEY, WA2DFI, N5EG, N1HAC, et al.



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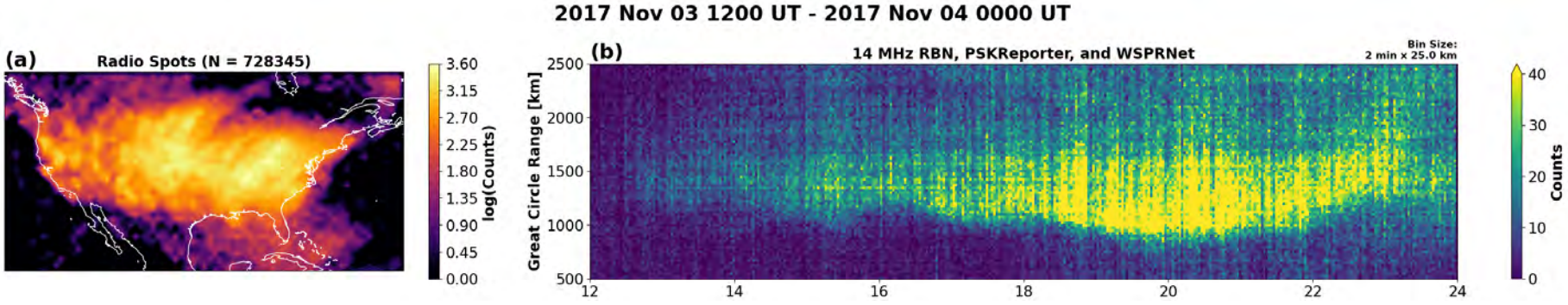
TIDs as a Frontier Research Topic

- Traveling Ionospheric Disturbances (TIDs) both affect HF radio propagation **and** are a key to understanding the relationship between the ionosphere, the lower atmosphere, and space.
- From an operational perspective, there are few (if any) TID predictive models in the unclassified domain that can be effectively used.
- From a science perspective, a properly developed empirical TID model can aid in identifying which physics drivers of TIDs are most important.



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TID Studies: NASA SWO2R & NSF CAREER

NASA SWO2R *(2 years, 2021-2023)*

Enabling Space Weather Research with Global Scale Amateur Radio Datasets

PI: N. Frissell W2NAF, Co-Is: T. Atkison, W. Engelke AB4EJ, and P. Erickson W1PJE

- Development of automated TID detection and parameter extraction algorithms.
- Develop empirical TID models that use geophysical indices as independent variables and model the probability of TID occurrence signatures in terrestrial HF communications.
- Validate models for the 7 and 14 MHz bands in the continental US and mainland Europe.
- Deposit RBN/PSKReporter/WSPRNet data into public NASA data repositories.

NASA Partner | The University of Scranton, A Jesuit University | University of Alabama | MIT Haystack Observatory

NSF CAREER (5 years, 2021-2026)

CAREER: Amateur Radio as a Tool for Studying Traveling Ionospheric Disturbances and Atmosphere-Ionosphere Coupling

PI: N. Frissell W2NAF

- Identify the amount of TIDs observed by HF communications systems that are and are not associated with geomagnetic activity.
- Determine the ability of data from amateur radio to fill TID observational gaps and be scientifically useful.
- Establish TID longitudinal dependence on the 2D stratospheric polar vortex configuration.
- Test the multistep vertical coupling paradigm of AGWs/TIDs theorized in the latest physics-based models.

NSF | The University of Scranton, A Jesuit University

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Other HamSCI or Community Projects

- **Festivals of Frequency Measurement** (KD8OXT, AD8Y)
- **WWV Modulation Experiment** (KD8OXT, AD8Y, WA5FRF, NQ6Z, W0DAS, N0RGT, et al…)
- **WSPRDaemon / WSPRNet Noise and Propagation Studies** (AI6VN and G3ZIL)
- **Simulation and Comparison of Weak-Signal VHF Propagation** (KE8KCT and Kate Duncan)
- **e-POP RRI Observations of the ARRL FMTs** (KD2SAK et al.)
- **40 m Trans-Pacific Propagation Studies** (N6NC et al.)

and many more…

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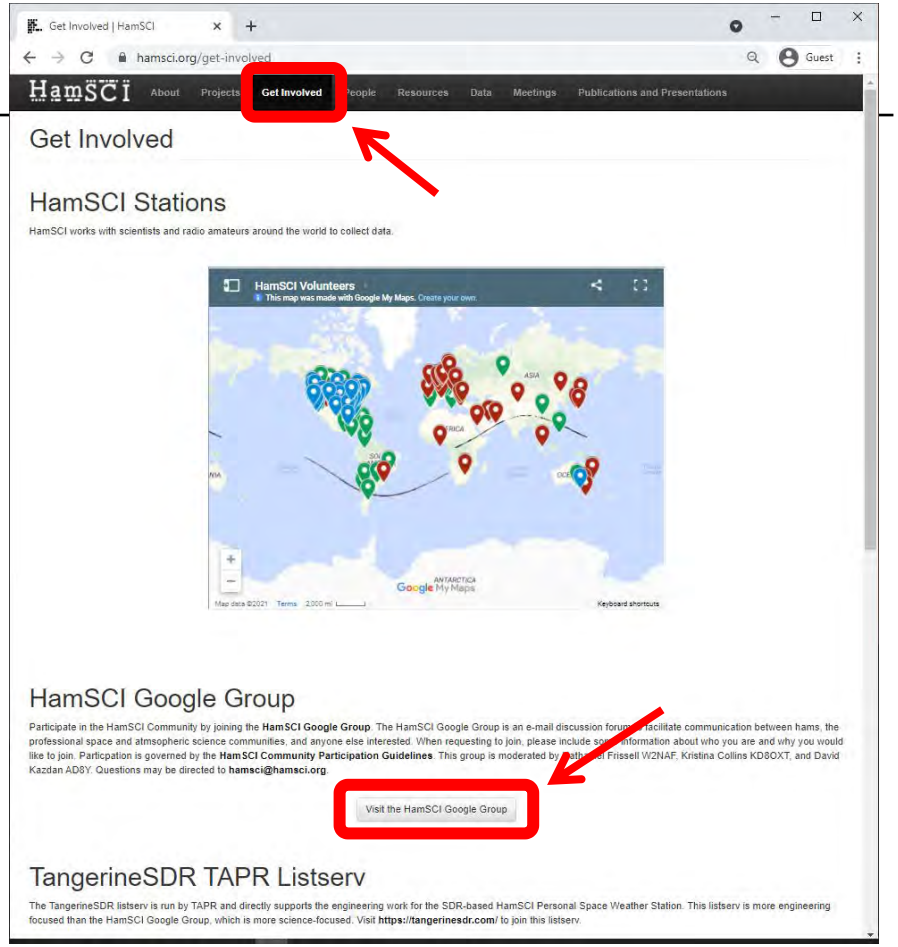
HamSCI Google Group

- The HamSCI Google Group now has over 450 members!
- Join by visiting https://hamsci.org/get-involved
- Open discussion for all things related to HamSCI.



HamSCI Zoom Telecons

TangerineSDR Telecon	**Engineering telecon to support the TangerineSDR and magnetometer board development.**	**Mondays at 9 PM Eastern**
Grape Telecon	**Telecon to support engineering and science related to the Grape (low-cost) Personal Space Weather Station.**	**Thursdays at 10 AM Eastern**
HamSCI Telecon	**Science-focused telecon open to all HamSCI topics.**	**Every other Thursday at 3 PM Eastern during the academic year**

Zoom links and calendar at http://hamsci.org/get-involved.

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HamSCI Workshop 2022 – Hopefully in person!

We welcome papers related to:

- Development of the PSWS
- Ionospheric Science
- Atmospheric Science
- Radio Science
- Space Weather
- Radio Astronomy

Theme: The Weather Connection

Watch hamsci.org/hamsci2022 and ARRL news for details.

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Acknowledgments

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- amateur radio community volunteers who have contributed to HamSCI projects.
- amateur radio community who voluntarily produced and provided the HF radio observations used in this paper, especially the operators of the Reverse Beacon Network (RBN, reversebeacon.net), the Weak Signal Propagation Reporting Network (WSPRNet, wsprnet.org), PSKReporter (pskreporter.info) qrz.com, and hamcall.net.
- use of the Free Open Source Software projects used in this analysis: Ubuntu Linux, python (van Rossum, 1995), matplotlib (Hunter, 2007), NumPy (Oliphant, 2007), SciPy (Jones et al., 2001), pandas (McKinney, 2010), xarray (Hoyer & Hamman, 2017), iPython (Pérez & Granger, 2007), and others (e.g., Millman & Aivazis, 2011).

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Thank You!

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