HamSCI and the 2017 Total Solar Eclipse

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Outline

I. What is HamSCI?
II. HamSCI Database
III. Eclipse Experiments
IV. Summary
The Ham radio Science Citizen Investigation is:

An organization 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 community and the general public.
HamSCI Membership

Lead HamSCI Organizer:
Dr. Nathaniel A. Frissell, W2NAF
New Jersey Institute of Technology
Center for Solar-Terrestrial Research

Members from:
- New Jersey Institute of Technology
- Virginia Tech
- American Radio Relay League
- Afreet Software
- Bob Jones University
- Dartmouth College
- Instituto de Telecomunicações /Universidade de Aveiro
- Johns Hopkins University APL
- MIT Haystack Observatory
- Montclair State University
- Reverse Beacon Network
- The Radio Club of America
- Rice University
- Royal Military College of Canada
- SciVision, Inc.
- SRI International
- University of Alabama
- University of Calgary
- University of Michigan
- The Amateur Radio Community

HamSCI at the 2016 American Geophysical Union Meeting
Total Solar Eclipse

21 August 2017

Partial Start: 1604 UT
Total Max: 1716 UT
Partial End: 1834 UT

Partial Start: 1720 UT
Total Max: 1851 UT
Partial End: 2013 UT

Figure: W. Strickling, Wikipedia
HamSCI Eclipse Research Questions

• What are the temporal and spatial scales of eclipse-induced ionospheric effects?

• Can we observe TIDs in the ionosphere caused by the eclipse?

• How does the eclipse affect HF propagation?
HamSCI Eclipse Experiments

• Solar Eclipse QSO Party (SEQP)
  • Ham Radio Contest-Like Event
  • Generate a quasi-random dataset
  • Data from RBN, PSKRepoter, WSPRNet, Logs

• HF Wideband Recording
  • Use SDRs to record large amounts of HF Spectrum

• HF Frequency Measurement Experiment
  • Measure changes in WWV, CHU frequency due to eclipse
HamSCI-Related Experiments

• Sky & Telescope AM Broadcast Experiment

• EclipseMob VLF Experiments

• Professional Measurements
  • MIT Haystack Incoherent Scatter Radar
  • GPS-TEC
  • Ionosondes
  • SuperDARN
  • Virginia Tech Field Ionosondes

VT Field Ionosonde at Shaw AFB
## Data Collection

<table>
<thead>
<tr>
<th>Source</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="https://hamsci.org">hamsci.org</a></td>
<td>- SEQP Log Files</td>
</tr>
<tr>
<td></td>
<td>- 571 Parsed Logs</td>
</tr>
<tr>
<td></td>
<td>- 28,694 QSOs</td>
</tr>
<tr>
<td><a href="https://zenodo.org">zenodo.org HamSCI Community</a></td>
<td>- 50 Submissions</td>
</tr>
<tr>
<td><a href="https://www.reversebeacon.net">Reverse Beacon Network</a></td>
<td>- 625,000 Spots</td>
</tr>
<tr>
<td><a href="https://pskreporter.com">PSKReporter</a></td>
<td>- Still counting…</td>
</tr>
<tr>
<td><a href="https://www.wsprnet.com">WSPRNet</a></td>
<td>- 642,586 Spots</td>
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</tbody>
</table>
Solar Eclipse QSO Party

- 571 submitted logs
- 28,694 QSOs
- 5,201 unique callsigns
- 4,371 unique grid squares
- 864 foreign callsigns

(from logs submitted to hamsci.org)
GMAG & SW Conditions

Nominal/Quiet Values

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>$B_T$</td>
<td>7 nT</td>
</tr>
<tr>
<td>$B_z$</td>
<td>+ for Quiet</td>
</tr>
<tr>
<td>$P_{dyn}$</td>
<td>1–6 nPa</td>
</tr>
<tr>
<td>$v_p$</td>
<td>450 km s$^{-1}$</td>
</tr>
<tr>
<td>$n_p$</td>
<td>6 cm$^{-3}$</td>
</tr>
<tr>
<td>$T$</td>
<td>$1.2 \times 10^5$ K</td>
</tr>
<tr>
<td>$D_{st}$</td>
<td>$&gt; -50$ nT</td>
</tr>
<tr>
<td>$K_p$</td>
<td>$\leq 3$</td>
</tr>
</tbody>
</table>

Sources: NOAA & Kyoto WDC

Boulder Sunspot Nr: 44
F10.7: 83 sfu
WA9VNJ 10MHz WWV Observations

Lat.: 41.2943° N  
Long.: 100.3271° W

Total Solar Eclipse
Duration of Totality: 2m30.1s
Magnitude: 1.012
Obscuration: 100.00%

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
<th>Time (UT)</th>
<th>Alt</th>
<th>Azi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start of partial eclipse (C1)</td>
<td>2017/08/21</td>
<td>16:31:01.8</td>
<td>48.6°</td>
<td>125.6°</td>
</tr>
<tr>
<td>Start of total eclipse (C2)</td>
<td>2017/08/21</td>
<td>17:54:29.1</td>
<td>58.6°</td>
<td>156.1°</td>
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<tr>
<td>Maximum eclipse</td>
<td>2017/08/21</td>
<td>17:55:44.2</td>
<td>58.7°</td>
<td>156.6°</td>
</tr>
<tr>
<td>End of total eclipse (C3)</td>
<td>2017/08/21</td>
<td>17:58:59.3</td>
<td>58.8°</td>
<td>157.2°</td>
</tr>
<tr>
<td>End of partial eclipse (C4)</td>
<td>2017/08/21</td>
<td>19:22:26.6</td>
<td>59.4°</td>
<td>198.6°</td>
</tr>
</tbody>
</table>
WWV 10 MHz Carrier Frequency, 8/20/17 (Control Day)
Received Near Milwaukee, WI. Mean=10,000,000.0022 Hz
GOES X-Ray Flux – Control Day

http://www.polarlicht-vorhersage.de/goes_archive
WWVB 60 kHz KD2BD Measurements

WWVB RX in Sea Girt, NJ by KD2DB

Eclipse Centered Over Great Circle Path

1400 UT 1800 UT 2200 UT

WWVB Relative Peak Carrier Amplitude
First Contact Over Path
Eclipse Centered Over Great Circle Path
Last Contact Over Path
Even shortwave listeners got into the act. Using the S meter on his Panasonic RF-4900 shortwave receiver, 88 year old John S. Erickson of Schenectady, NY (father of Extra class licensee and professional ionospheric researcher Phil Erickson W1PJE) recorded the signal strength he heard from time signals WWV at 10 and 15 MHz every 10 minutes during eclipse passage.
Solar Eclipse QSO Party (SEQP)

• August 21, 2017 from 1400 – 2200 UT

• Contest-like
  • 2 Points CW or Digital
  • 1 Point for Phone
  • Multiply Score by # of Grids

• Exchange
  • RST + 6 Character Grid Square

• Data sources
  • Reverse Beacon Network
  • PSKReporter
  • WSPRNet
  • Participant-submitted logs

http://hamsci.org/seqp
SEQP Log Submission

SEQP Logs must be submitted by **Saturday, September 30, 2017 at 2359 UTC.**

Rules for the SEQP can be found [here](#).

### Personal Information

Please select one:  
- [ ] Single-operator  
- [ ] Multi-operator

First Name  
*Appears on Certificate*

Last Name  
*Appears on Certificate*

Station Callsign  
*Appears on Certificate*

E-Mail Address

Station Grid Square  
* [Grid square calculator](#)

Primary TX Model

TX Power (W)
SEQP RBN Spots

RBN SEQP Spots by Band (Contiguous US TX and RX Only)

# Spots

<table>
<thead>
<tr>
<th>Band</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>10m</td>
<td>Black</td>
</tr>
<tr>
<td>15m</td>
<td>Blue</td>
</tr>
<tr>
<td>20m</td>
<td>Orange</td>
</tr>
<tr>
<td>40m</td>
<td>Cyan</td>
</tr>
<tr>
<td>80m</td>
<td>Green</td>
</tr>
<tr>
<td>160m</td>
<td>Red</td>
</tr>
</tbody>
</table>

Timestamp (UTC)

0-12000

12:00 14:00 16:00 18:00 20:00 22:00
SEQP Raytrace Simulation

Non-Eclipsed

Eclipsed

- NRL SAMI3 Ionosphere
- PHaRLAP Raytrace Toolbox
- 7 MHz
- TX: AC4PA, Georgia
- RX: WE9V, Wisconsin
SEQP Raytrace Simulation

Location of Simulated Stations

- Receiver
- Transmitter
Non-Eclipse Simulated Skip Distance

Simulated Median "Hop" Ground Distance (Base)
Eclipse Simulated Skip Distance

Simulated Median "Hop" Ground Distance (Eclipse)
Eclipse Simulated QSO Distance

Simulated Median QSO Distance (Eclipse)

Distance (km)

1.83 MHz
3.53 MHz
7.03 MHz
14.03 MHz
21.03 MHz

Timestamp (UTC)

16:00 17:00 18:00 19:00 20:00 21:00 22:00
SEQP Observed Median QSO Distance

SEQP Median QSO Distance

Distance (km)
5000 - 4000 - 3000 - 2000 - 1000 - 2

Timestamp (UTC)

16:00 17:00 18:00 19:00 20:00 21:00 22:00

- 1.0 MHz
- 3.0 MHz
- 7.0 MHz
- 14.0 MHz
- 21.0 MHz
Summary

• **Ham Radio Science Citizen Investigation**
  • An organization that allows university researchers to collaborate with the amateur radio community in scientific investigations.

• **2017 Total Solar Eclipse**
  • Shadow of eclipse stops ion production in ionosphere
  • Amateurs observed Doppler Shifts, Phase Shifts, and Amplitude changes in WWV, WWVB, and AM radio station reception.
  • SEQP observations suggest raising of the F layer and depletion of the D layer.
Special Thanks

- John Ackermann, N8UR
- David Bern, W2LNX
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- Andy Gerrard, KD2MCQ
- Bob Gerzoff, WK2Y
- Michael Hirsch, N2NRL
- Steve Kaeppler, AD0AE
- John Magliacane, KD2BD
- Bob McGwier, N4HY
- Ethan Miller, K8GU
- Magda Moses, KM4EGE
- Carl Luetzelschwab, K9LA
- Steve Reyer, WA9VNJ
- Sam Rose, KC2LRC
- Alex Shovkoplyas, VE3NEA
- Ward Silver, N0AX
- Pete Smith, N4ZR
- Pete Teklinski, WW2I
- Dick Williams, W3OA
- The ARRL
- All hams who have participated in HamSCI projects.
References and Acknowledgments


The results published in this paper were obtained using the HF propagation toolbox, PHaRLAP, created by Dr Manuel Cervera, Defence Science and Technology Group, Australia (manuel.cervera@dsto.defence.gov.au). This toolbox is available by request from its author.
K2MFF – The NJIT Amateur Radio Club
HamSCI Workshop at NJIT

Friday, Feb. 23 – Saturday, Feb. 24, 2018
New Jersey Institute of Technology
Newark, NJ

HamSCI

We welcome papers and presentations on 2017 Eclipse Ionospheric Effects using Amateur Radio and related data.
Watch hamsci.org and ARRL news for details.
Thank you!