

# HamSCI and the 2017 Total Solar Eclipse

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# Outline

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- I. What is HamSCI?**
- II. HamSCI Database**
- III. Eclipse Experiments**
- IV. Summary**

# HamSci

The **H**am radio **S**cience **C**itizen **I**nvestigation is:



[hamsci.org/dayton2017](http://hamsci.org/dayton2017)

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.



KD2JAO & WB2JSV in the SEQP

# HamSCI Membership

*Lead HamSCI Organizer:*

**Dr. Nathaniel A. Frissell, W2NAF**

*New Jersey Institute of Technology  
Center for Solar-Terrestrial Research*



HamSCI at the 2016  
American Geophysical Union Meeting

## 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

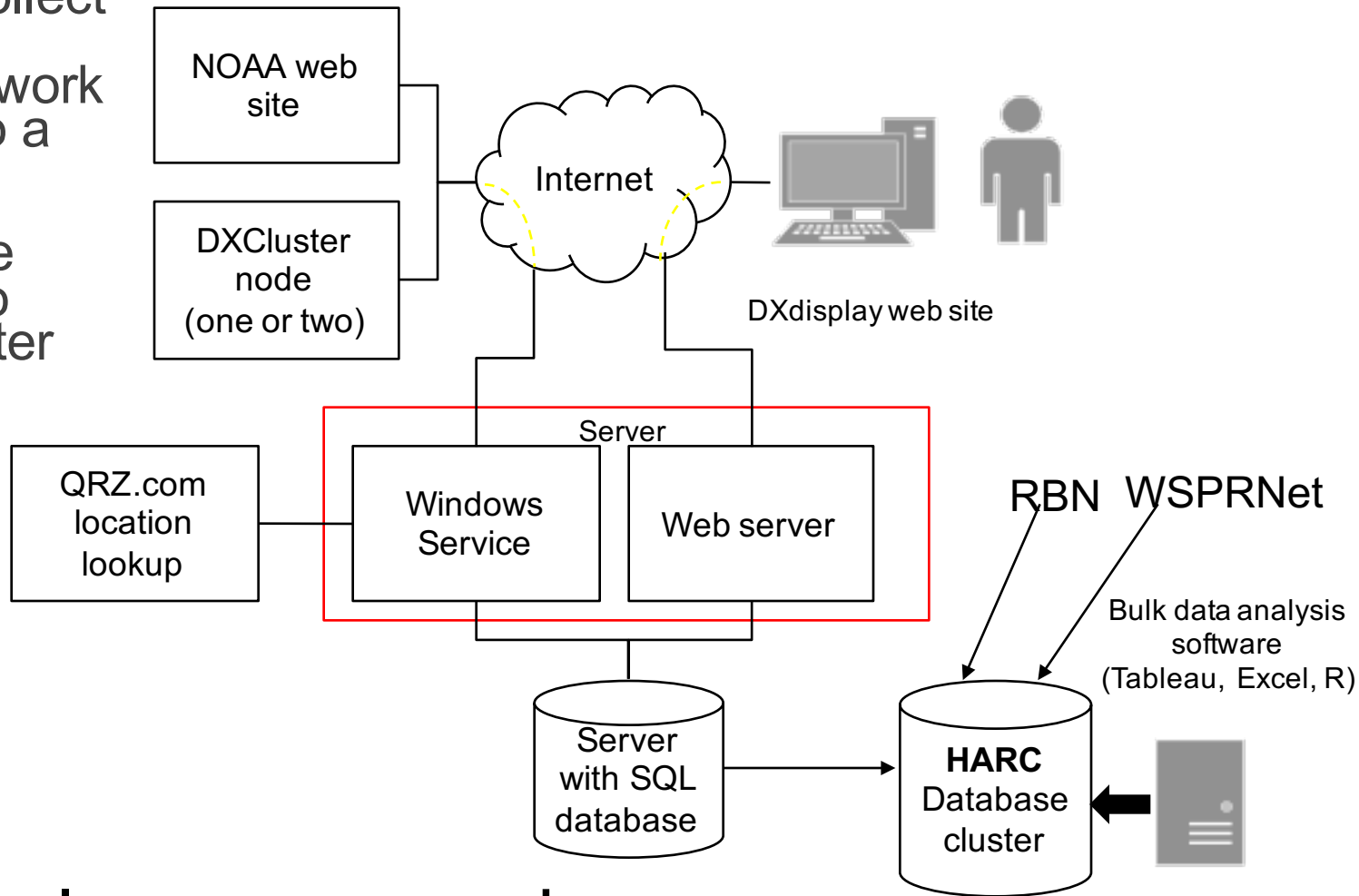
# Data Analytics & Ham Radio

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- We can use **Data Analysis** to better understand the physics of radio, and the behavior of the ionosphere in particular
- We can use **Data Analytics** to:
  - See what bands are hot now
  - Observe the trends in band openings both short- and long-term
  - Study relationships between solar/ionospheric events and propagation
  - Decide when and where (what band) to get on the air, switch bands, chase a desired DX station, how to turn the antenna rotor, determine how best to communicate with an area affected by a regional disaster
  - Forecast band performance based on history
- Junk Data (is there an impact from false spots on analytics? E.g. made-up callsigns, invalid grids, missing lat-long info)
- Impact is minimal to negligible because the large amount of data tends to “average out” the error (noise); this is a fundamental tenet of “big data” analytics

# DX Display

- A system to collect spots from the DXCluster network and save all to a database
- Import multiple databases into database cluster

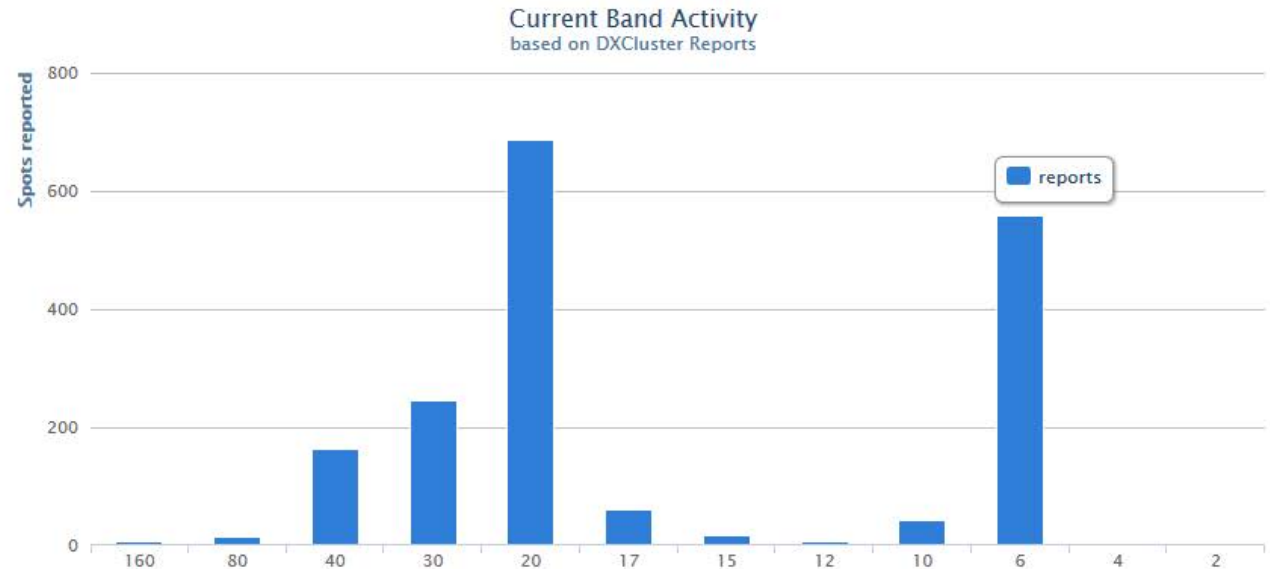


[www.dxdisplay.caps.ua.edu](http://www.dxdisplay.caps.ua.edu)

# DX Display

## RF Propagation Analytics

- Activity
  - Current
  - Trending/History
- Maps
- Search
- About + Documentation
- Software



### Data Filters

Start Date/Time (YYYY-MM-DD HH:MM) 6/30/2017 12:40:12 PM (Z)

End Date/Time (YYYY-MM-DD HH:MM) 6/30/2017 8:40:12 PM (Z)

Heard in: United States  Include DX Cluster spots

Include sample of WSPR spots

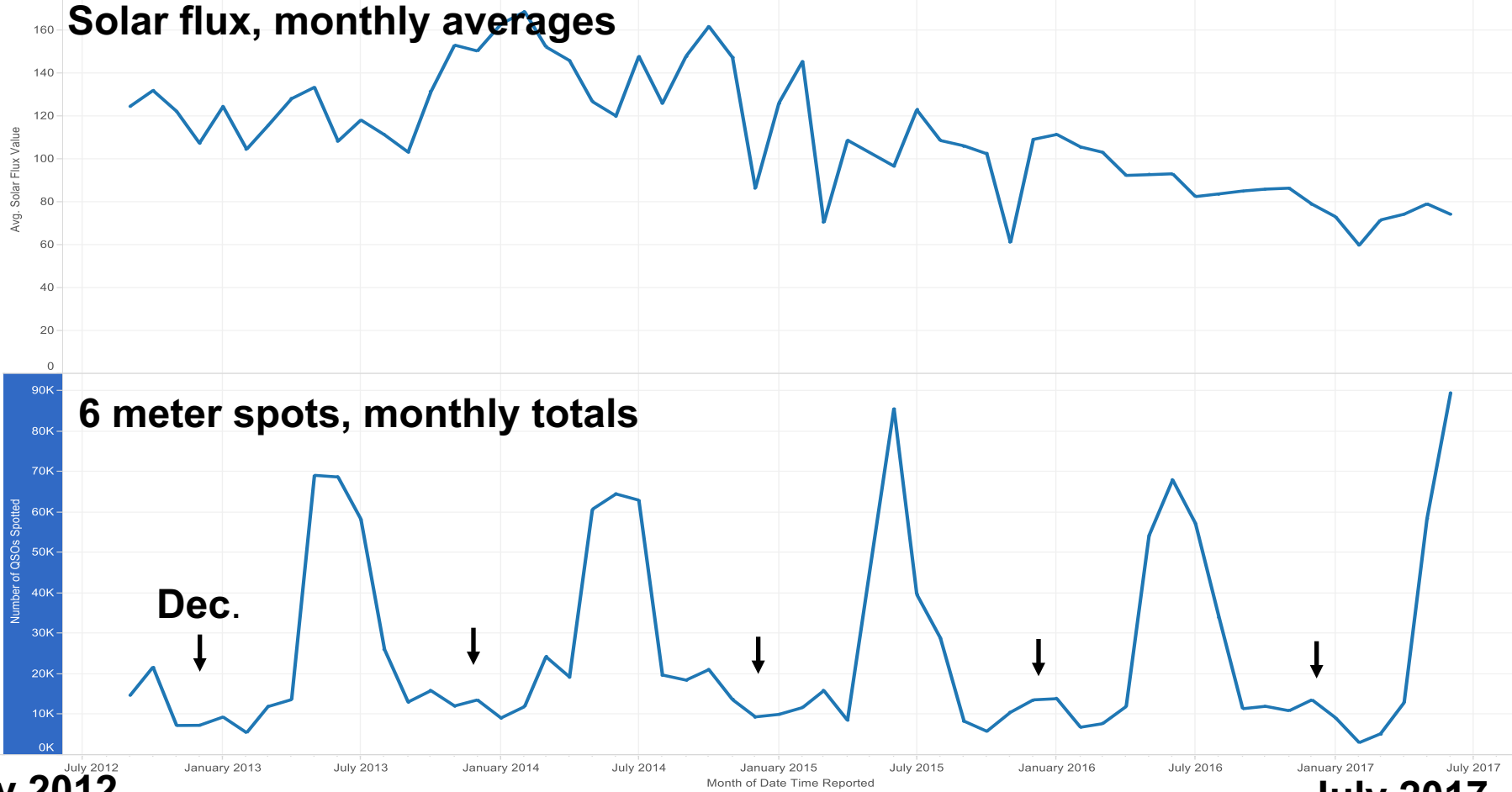
[www.dxdisplay.caps.ua.edu](http://www.dxdisplay.caps.ua.edu)

# DX Display

VHF

6m Qs vs flux

Band Value



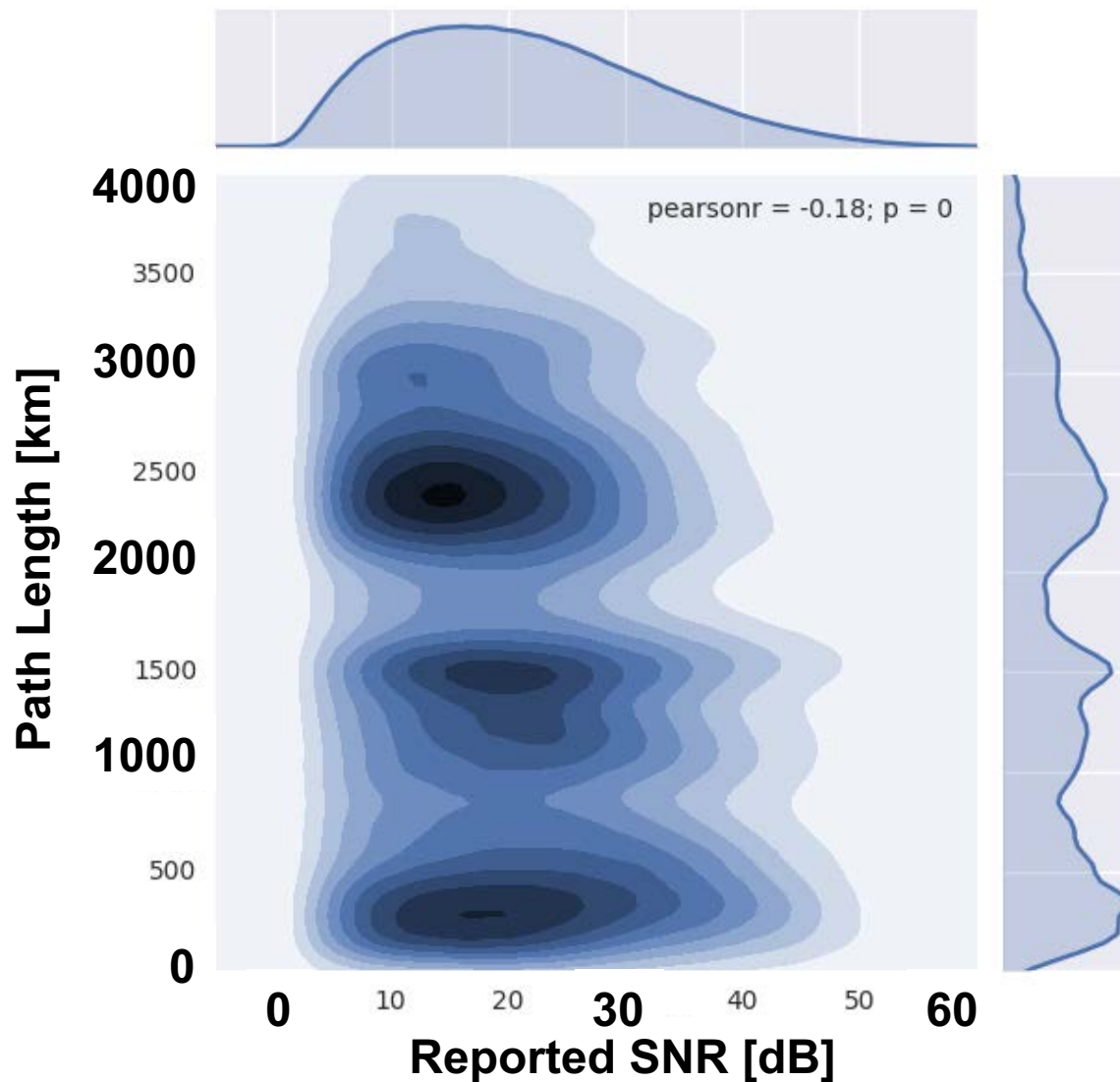
The trends of Average of Solar Flux Value and sum of Number of Records for Date Time Reported Month broken down by Band Value. The view is filtered on average of Solar Flux Value, Band Value and Date Time Reported Month. The average of Solar Flux Value filter ranges from 47.0 to 169.6. The Band Value filter keeps 6. The Date Time Reported Month filter ranges from September 2012 to June 2017.





# Distribution KDE RBN 7 MHz

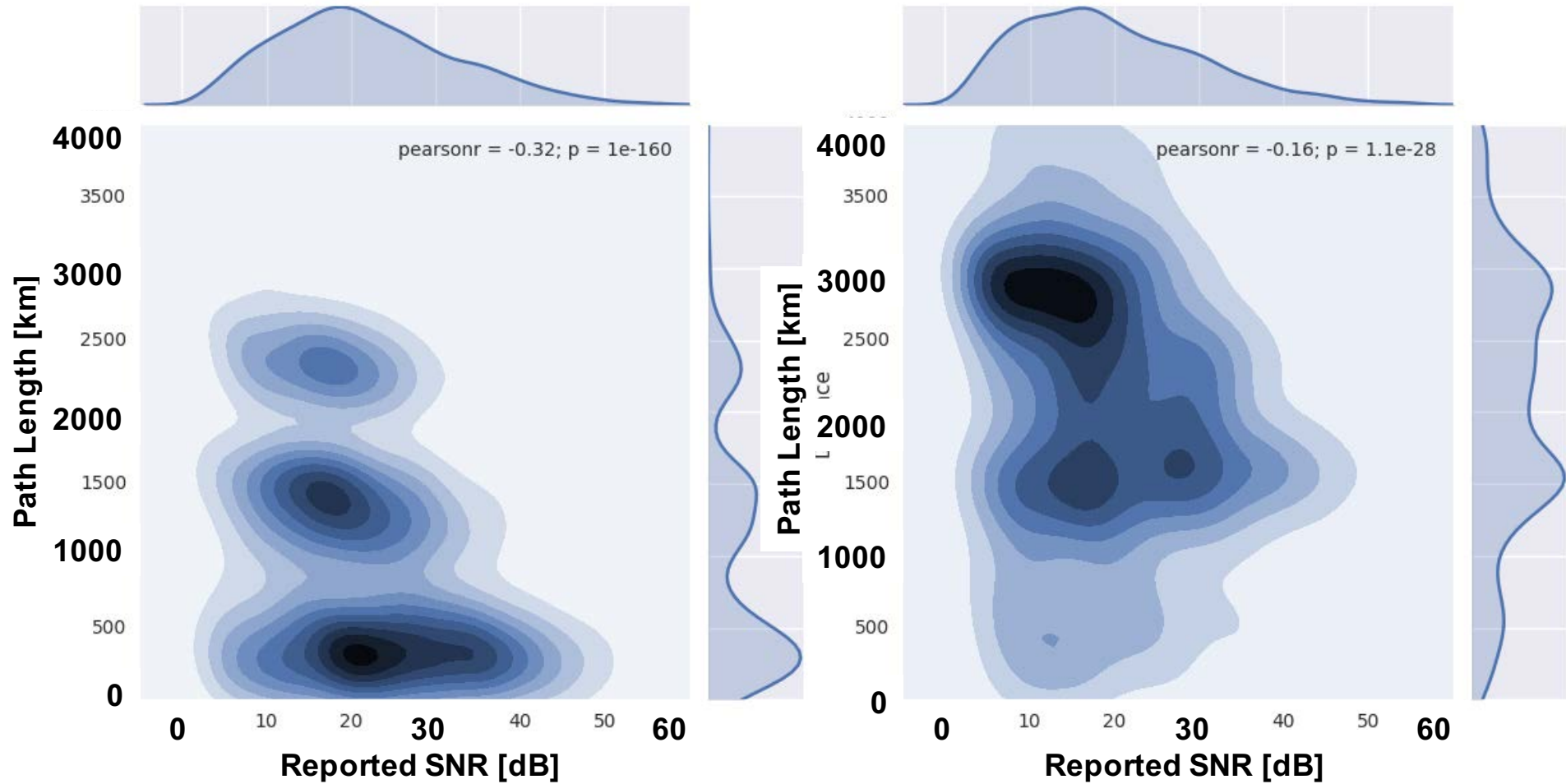
7 MHz  
RBN Data  
2009 - 2016



# RBN 7MHz January 2012

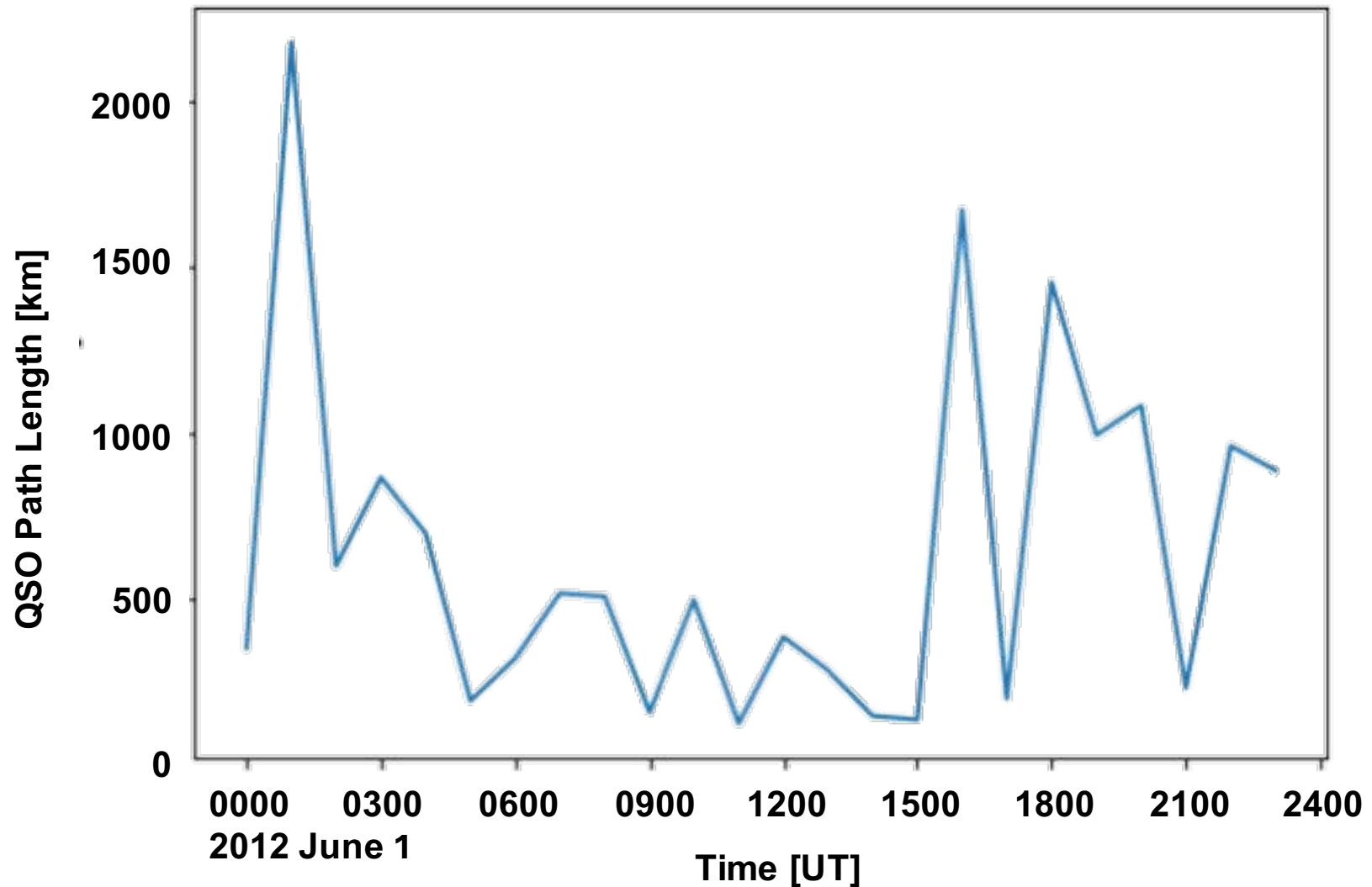
## Day

## Night



# 40 m RBN Touchdown Distances

40m touchdown Distances over Time



# Total Solar Eclipse

21 August 2017

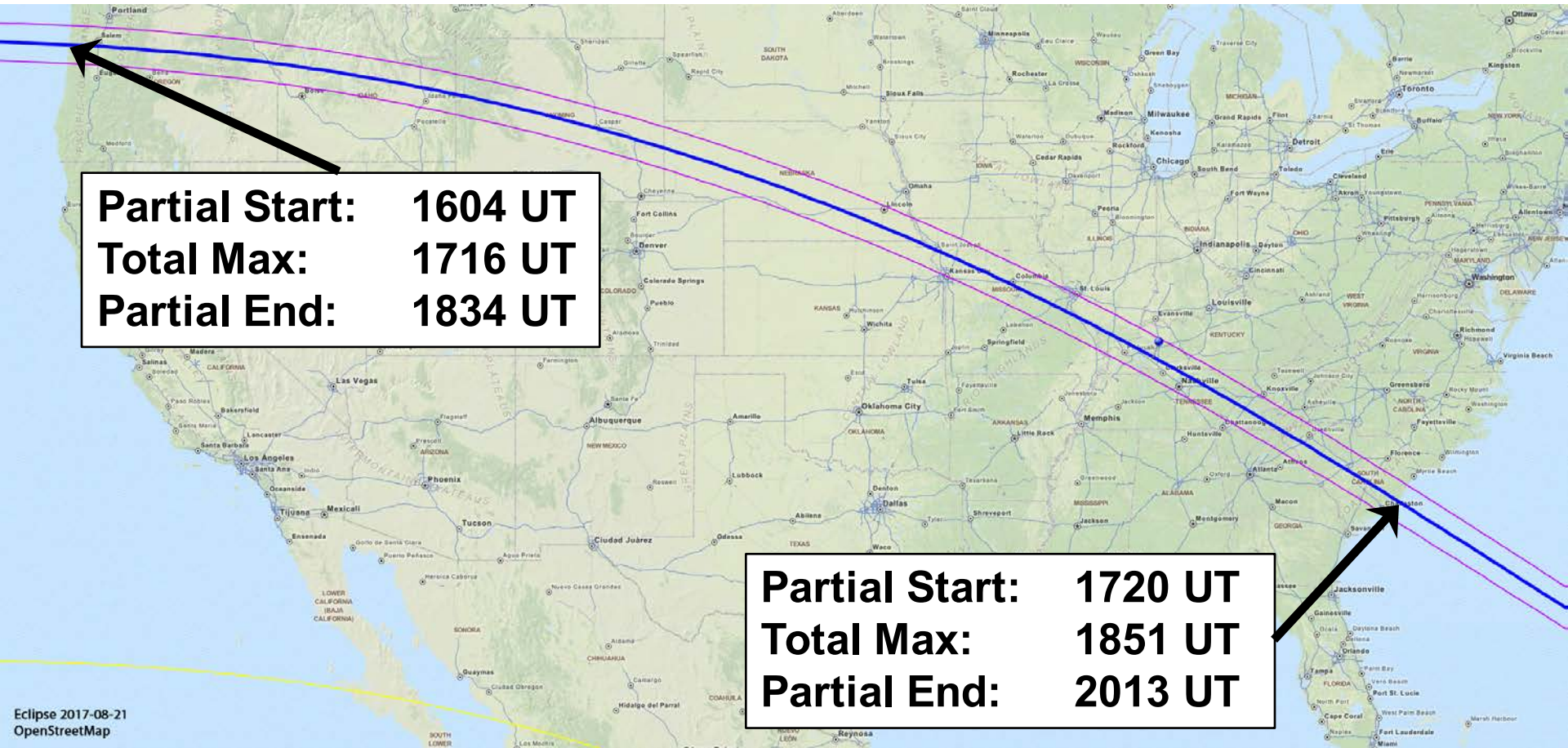


Figure: W. Strickling, Wikipedia

# HamSCI Eclipse Research Questions

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- 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

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- **Solar Eclipse QSO Party (SEQP)**
  - Ham Radio Contest-Like Event
  - Generate a quasi-random dataset
  - Data from RBN, PSKReporter, 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

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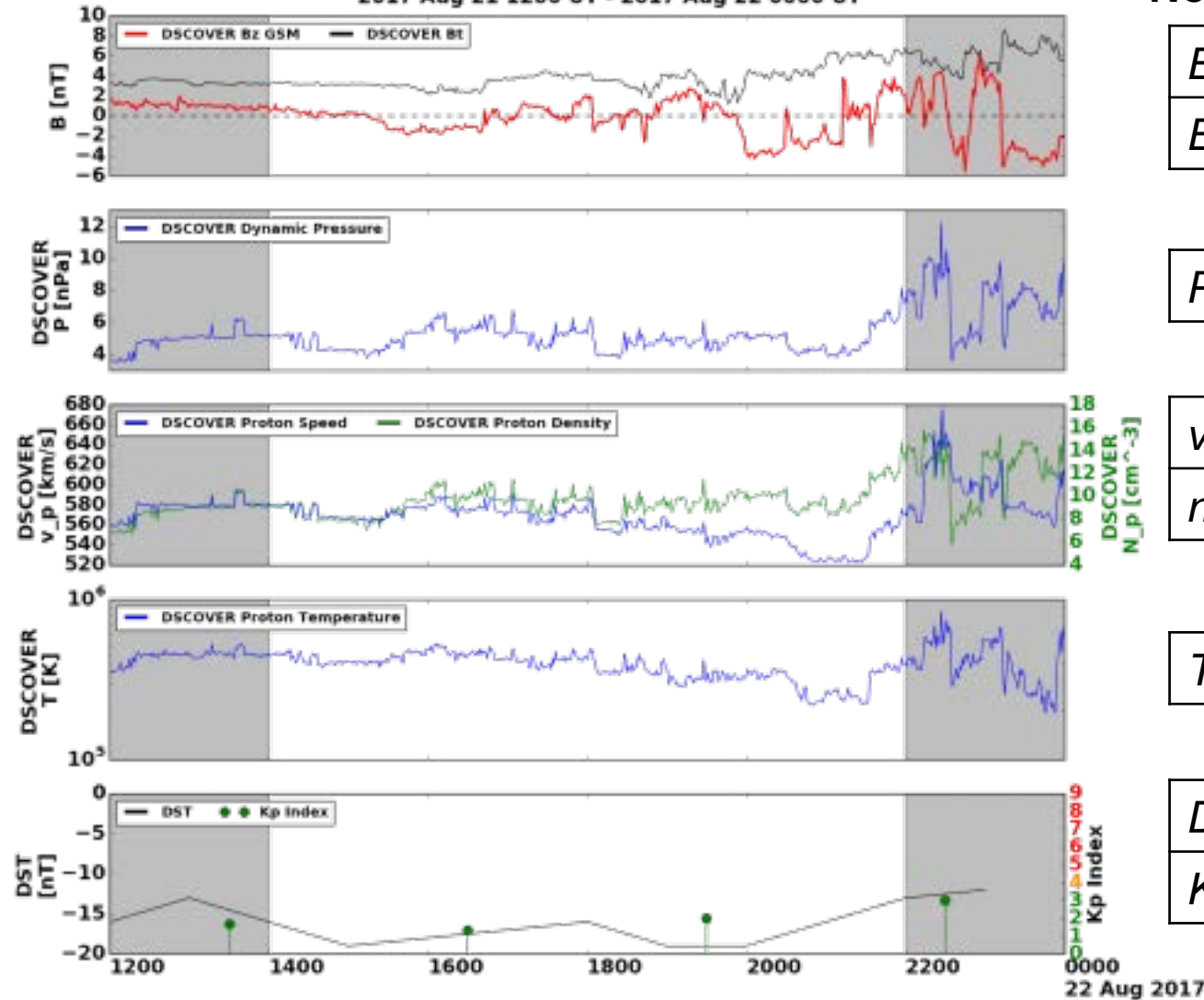
<b>hamsci.org</b> <ul style="list-style-type: none"><li>• SEQP Log Files</li></ul>	<ul style="list-style-type: none"><li>• 571 Parsed Logs</li><li>• 28,694 QSOs</li></ul>
<b>zenodo.org HamSCI Community</b> <ul style="list-style-type: none"><li>• Wideband Recording</li><li>• Frequency Measurements</li></ul>	<ul style="list-style-type: none"><li>• 50 Submissions</li></ul>
<b>Reverse Beacon Network</b>	<ul style="list-style-type: none"><li>• 625,000 Spots</li></ul>
<b>PSKReporter</b>	<ul style="list-style-type: none"><li>• Still counting...</li></ul>
<b>WSPRNet</b>	<ul style="list-style-type: none"><li>• 642,586 Spots</li></ul>



# GMAG & SW Conditions

Boulder Sunspot Nr: 44  
F10.7: 83 sfu

Geomagnetic Environment Summary  
2017 Aug 21 1200 UT - 2017 Aug 22 0000 UT



## Nominal/Quiet Values

$B_T$	7 nT
$B_z$	+ for Quiet

$P_{dyn}$	1–6 nPa
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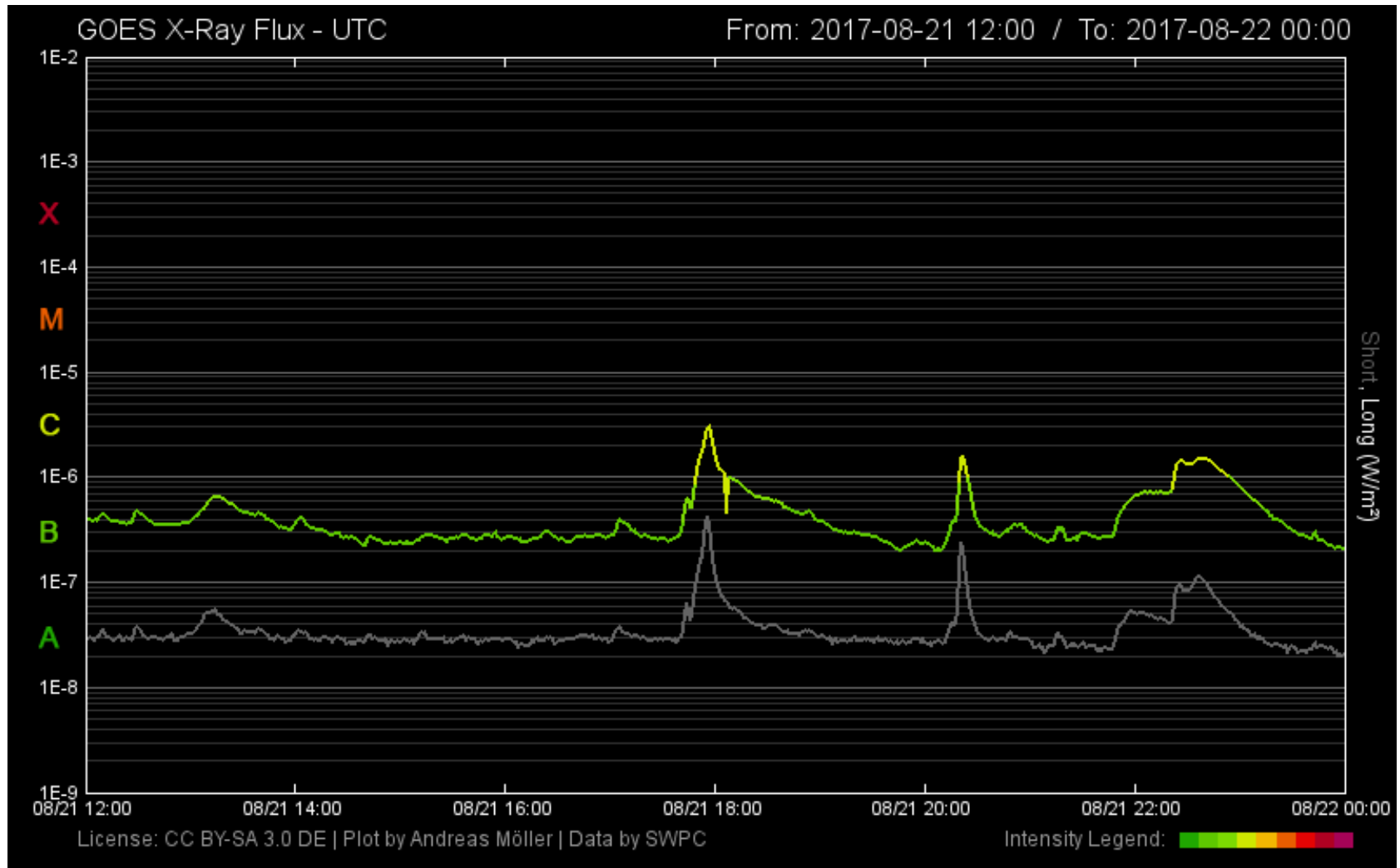
$v_p$	450 km s <sup>-1</sup>
$n_p$	6 cm <sup>-3</sup>

$T$	$1.2 \times 10^5$ K
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$D_{st}$	> -50 nT
$K_p$	$\leq 3$

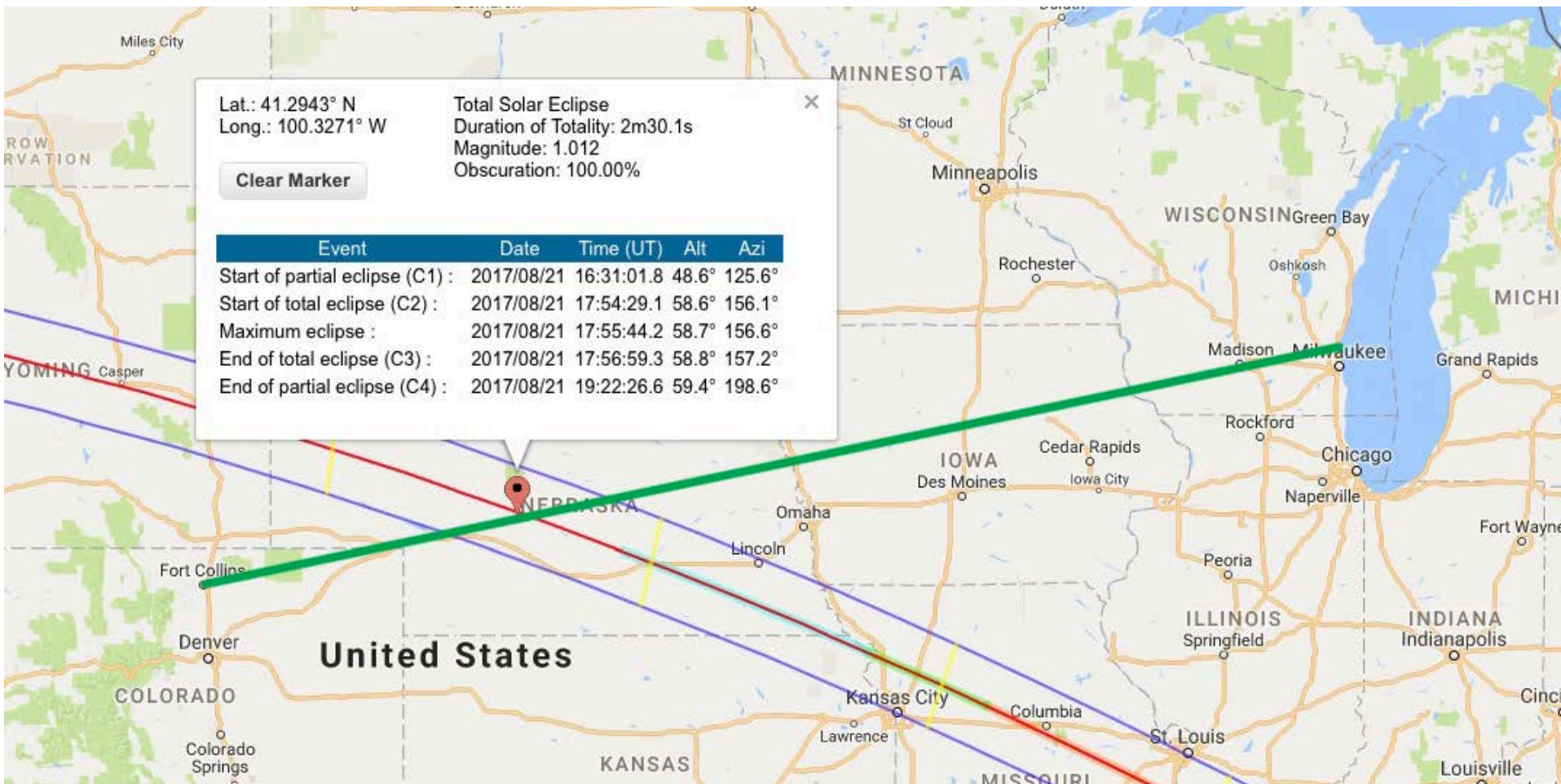
Sources: NOAA & Kyoto WDC

# GOES X-Ray Flux



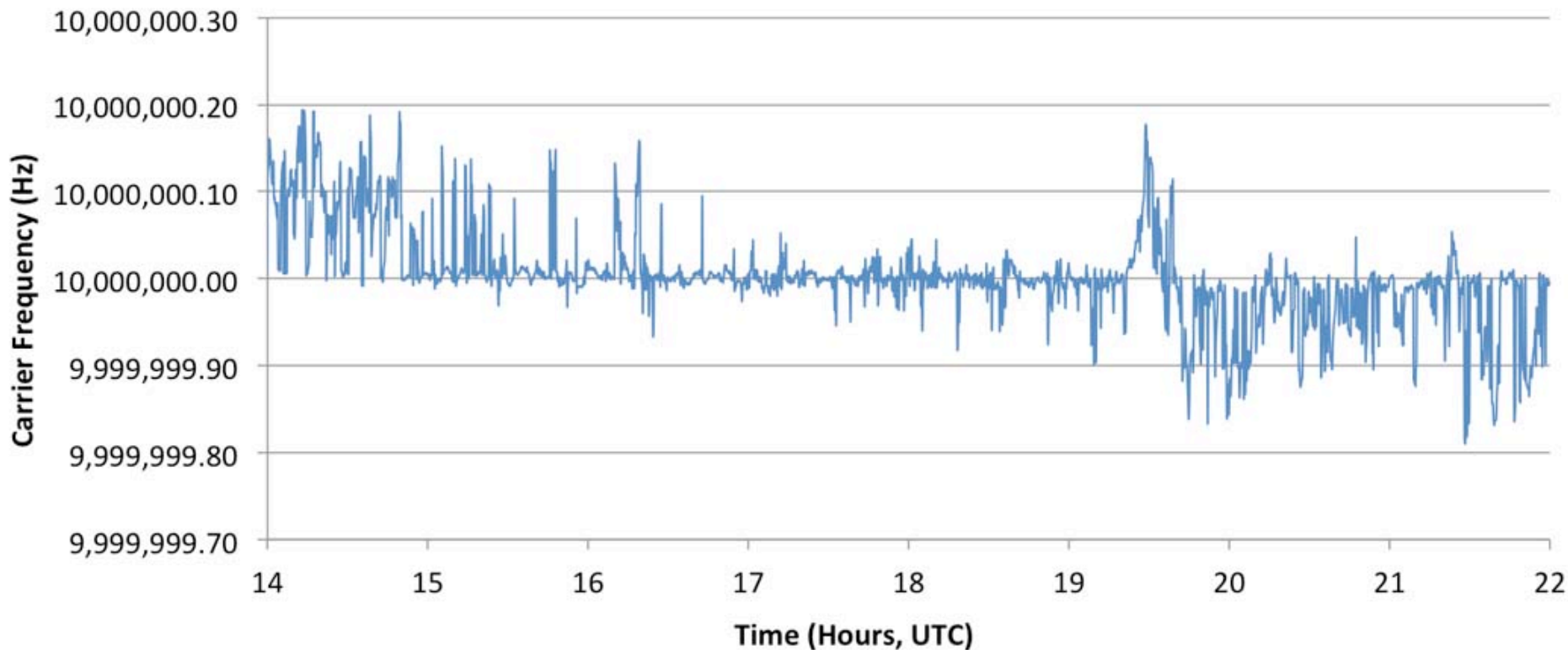
[http://www.polarlicht-vorhersage.de/goes\\_archive](http://www.polarlicht-vorhersage.de/goes_archive)

# WA9VNJ 10MHz WWV Observations

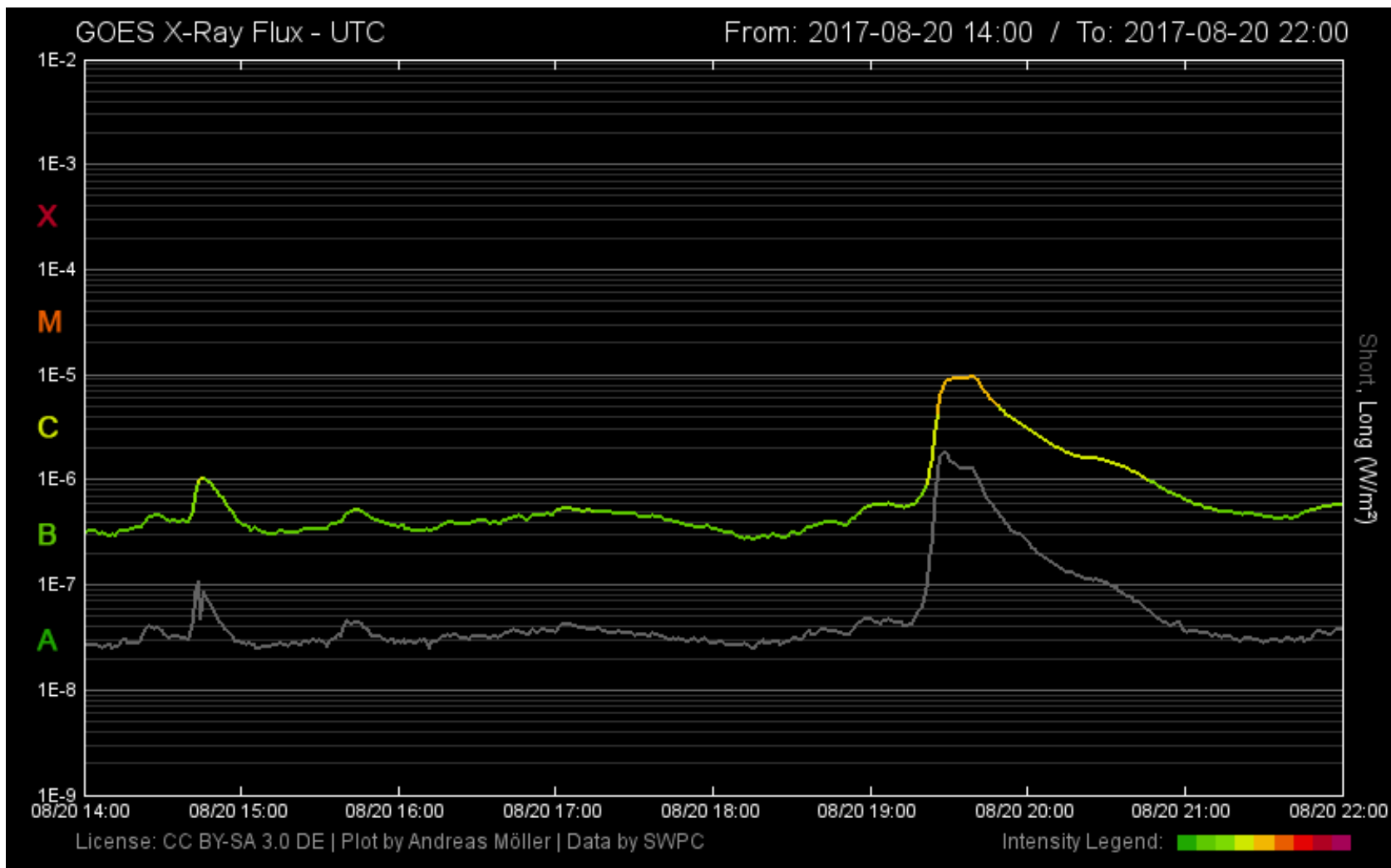


# WA9VNJ 10MHz WWV Observations

WWV 10 MHz Carrier Frequency, 8/20/17 (Control Day)  
Received Near Milwaukee, WI. Mean=10,000,000.0022 Hz



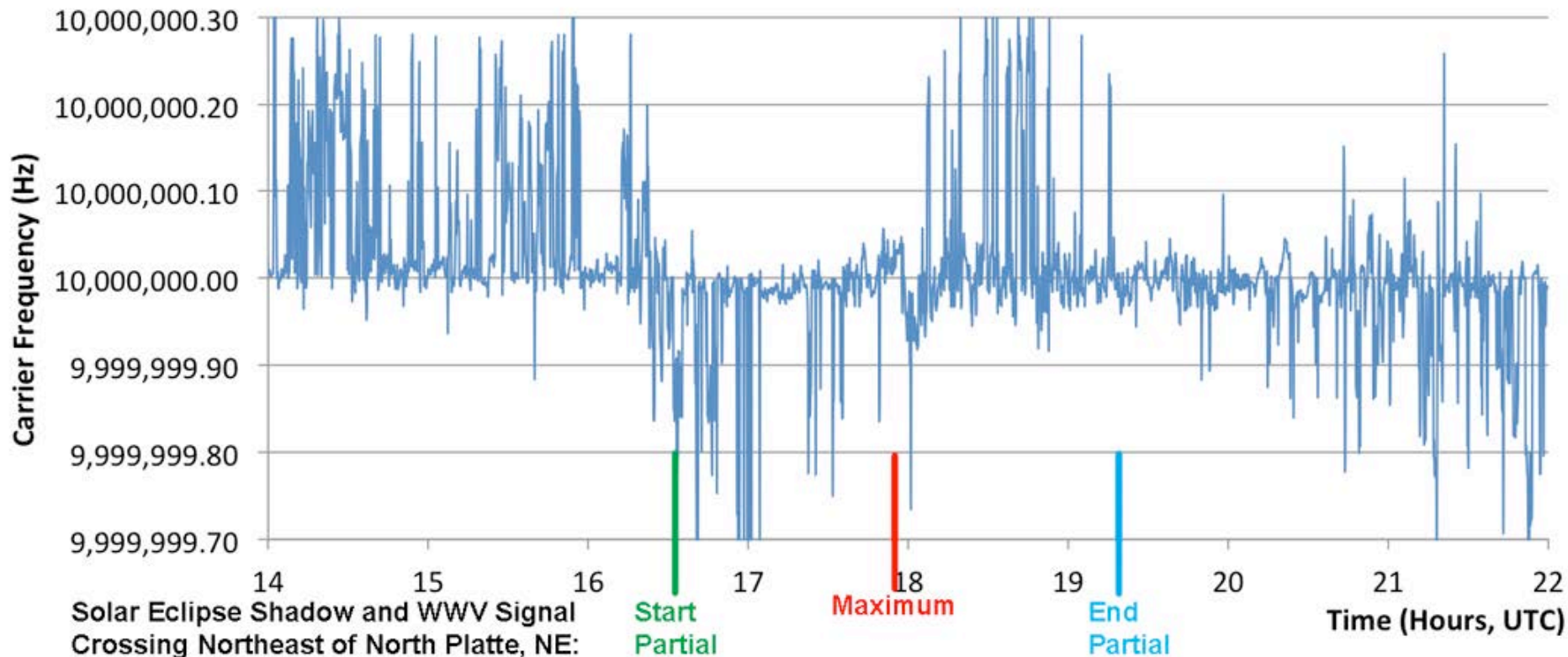
# GOES X-Ray Flux – Control Day



[http://www.polarlicht-vorhersage.de/goes\\_archive](http://www.polarlicht-vorhersage.de/goes_archive)

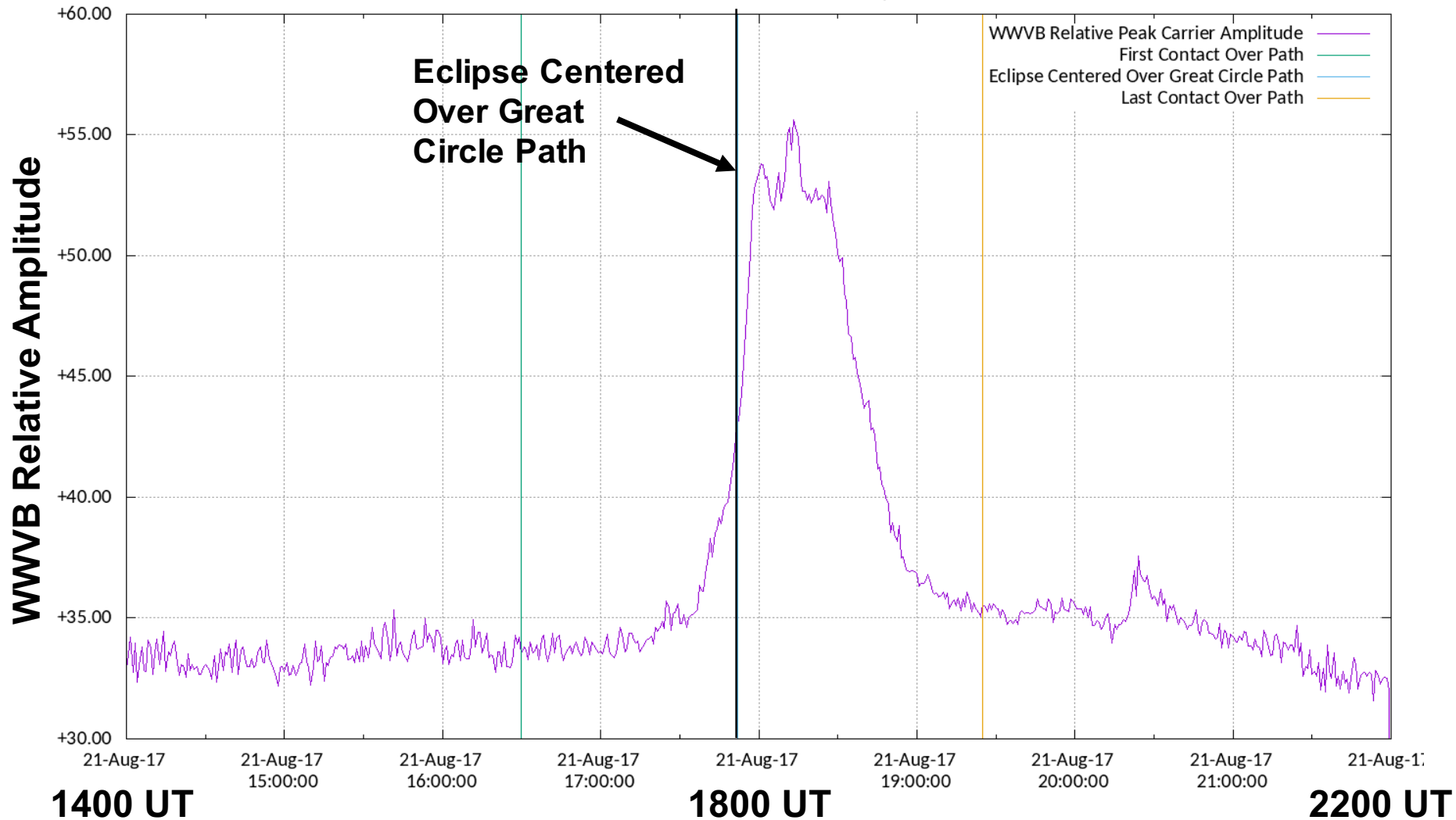
# WA9VNJ 10MHz WWV Observations

WWV 10 MHz Carrier Frequency, 8/21/17 (Eclipse Day)  
Received Near Milwaukee, WI. Mean=10,000,000.0096 Hz



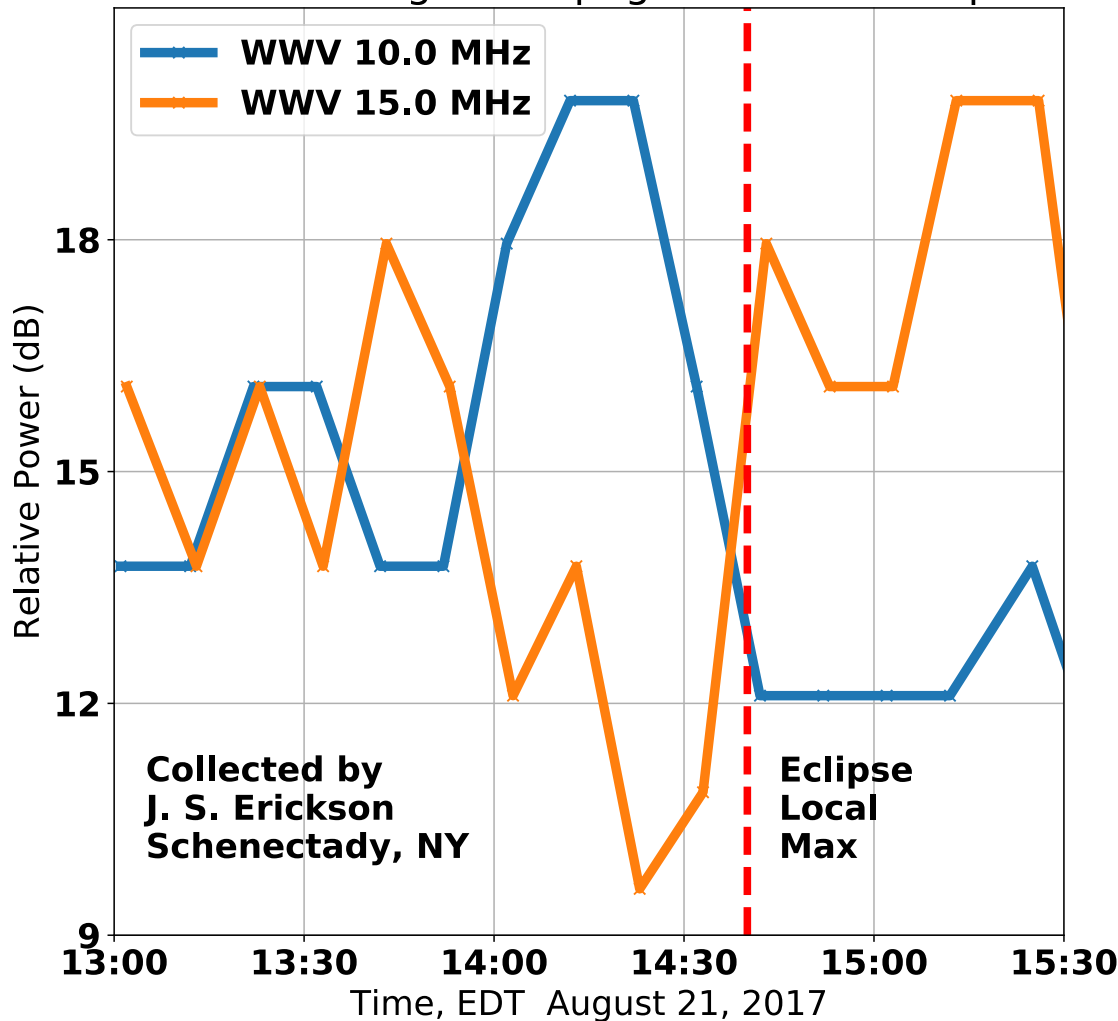
# WWVB 60 kHz KD2BD Measurements

## WWVB RX in Sea Girt, NJ by KD2DB



# 10 & 15 MHz WWV (Schenectady, NY)

Shortwave Signal Propagation 2017 Eclipse



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)

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- 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

Guest

hamsci.org/submit-logs

HamSCI About Projects Get Involved People Resources Publications

## 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)**

# Solar Eclipse QSO Party

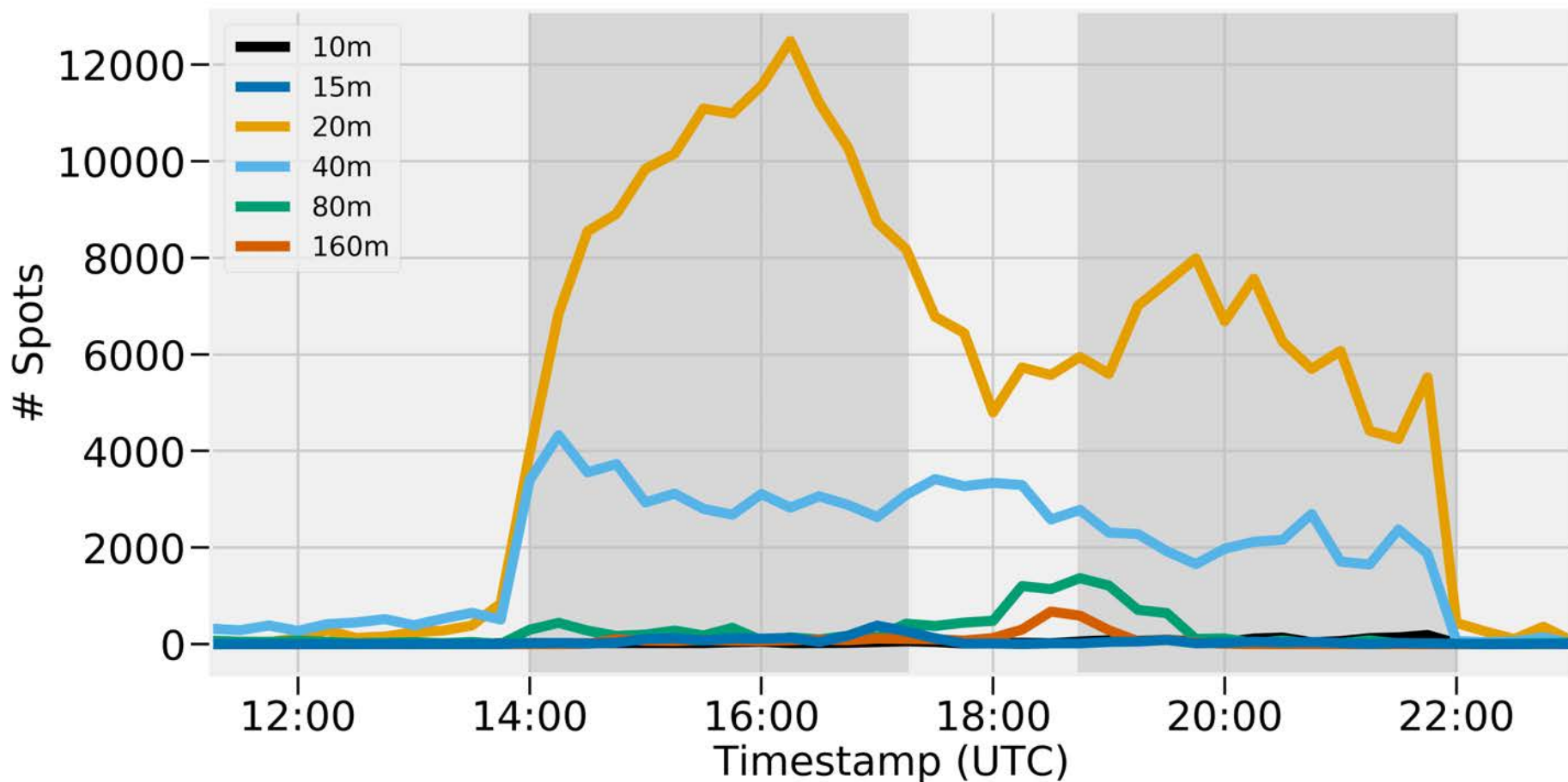
- 571 submitted logs
- 28,694 QSOs
- 5,201 unique callsigns
- 4,371 unique grid squares
- 864 foreign callsigns

*(from logs submitted to hamsci.org)*

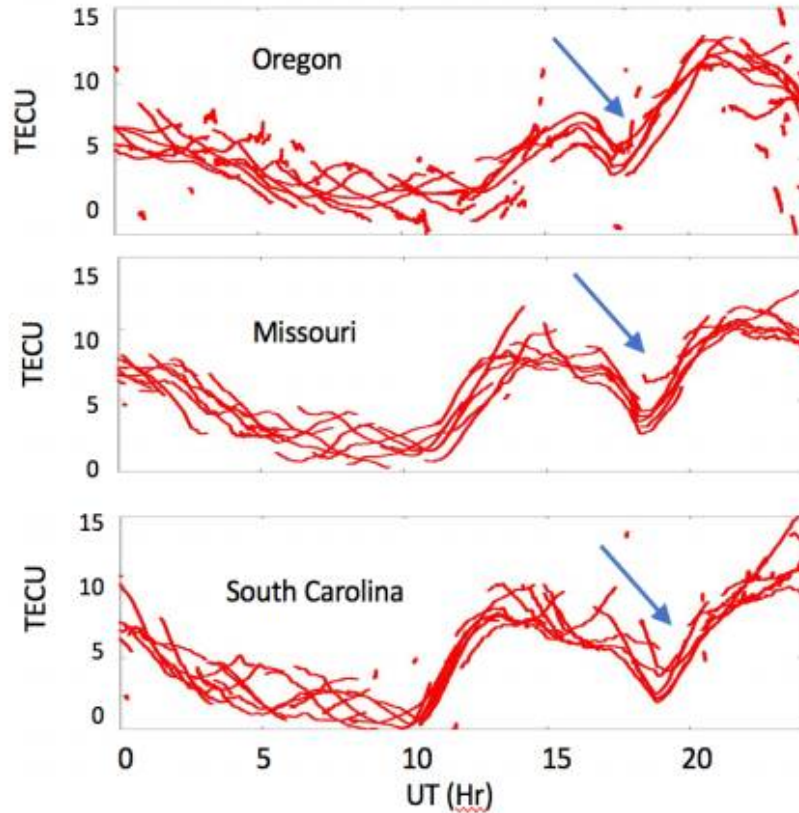


# SEQP RBN Spots

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

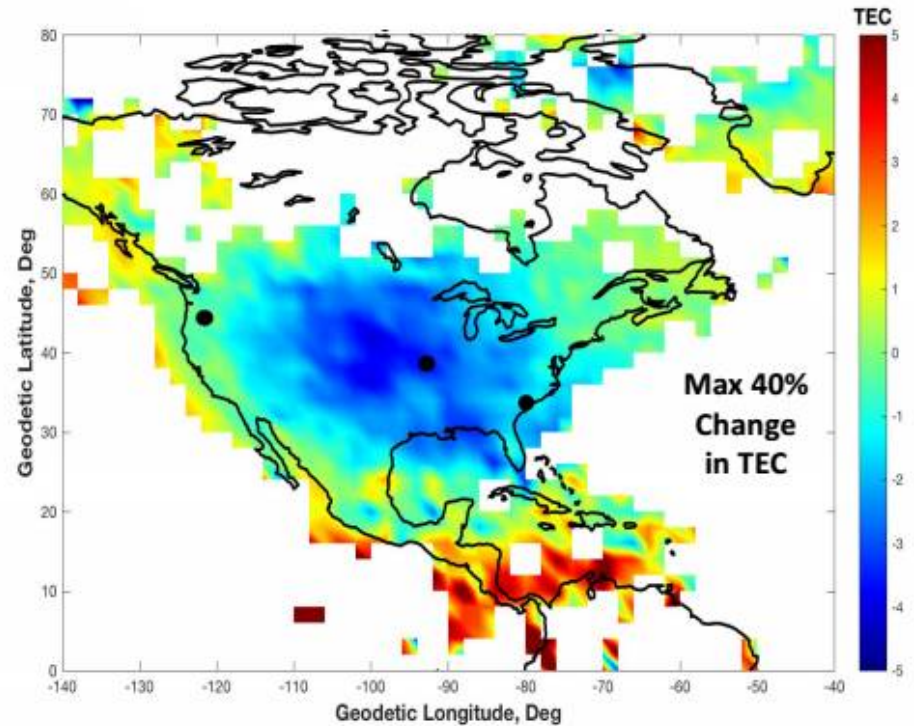


# GPS-TEC Observations



## Solar Eclipse GNSS Vertical Total Electron Content 21 August 2017

Difference in TEC at 18:15 UT from start of solar eclipse at 16:45 UT

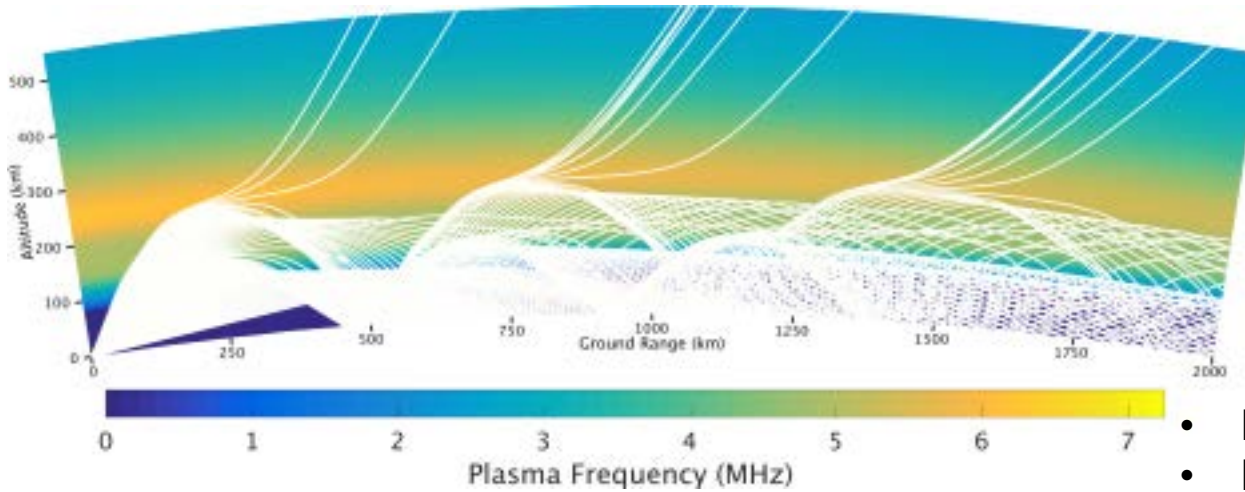


Support: NSF AGS-1242204, NASA NNX17AH71G

Courtesy of Anthea Coster, MIT Haystack Observatory

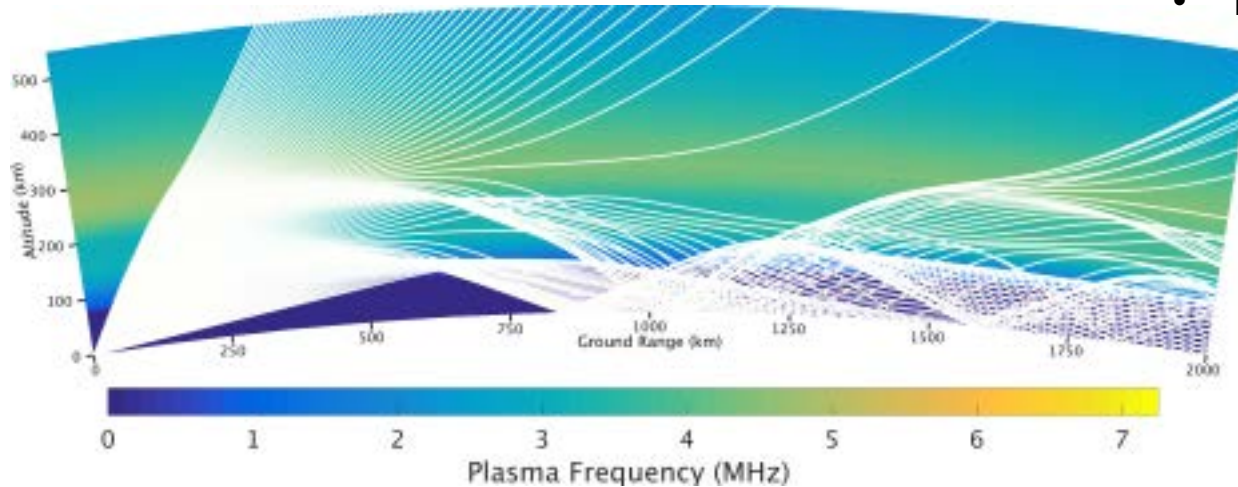
# SEQP Raytrace Simulation

Non-Eclipsed



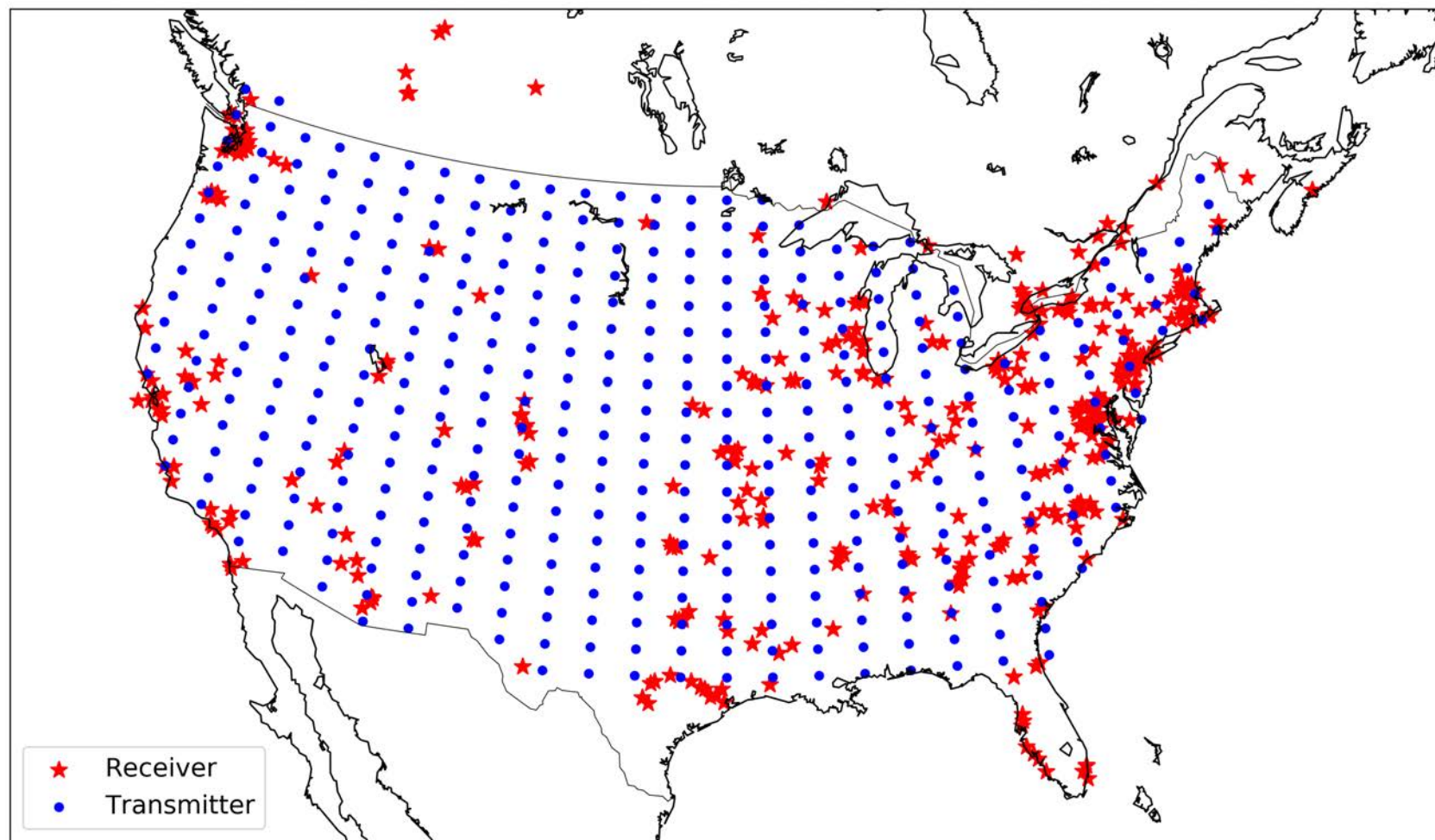
- NRL SAMI3 Ionosphere
- PHaRLAP Raytrace Toolbox
- 7 MHz
- TX: AC4PA, Georgia
- RX: WE9V, Wisconsin

Eclipsed



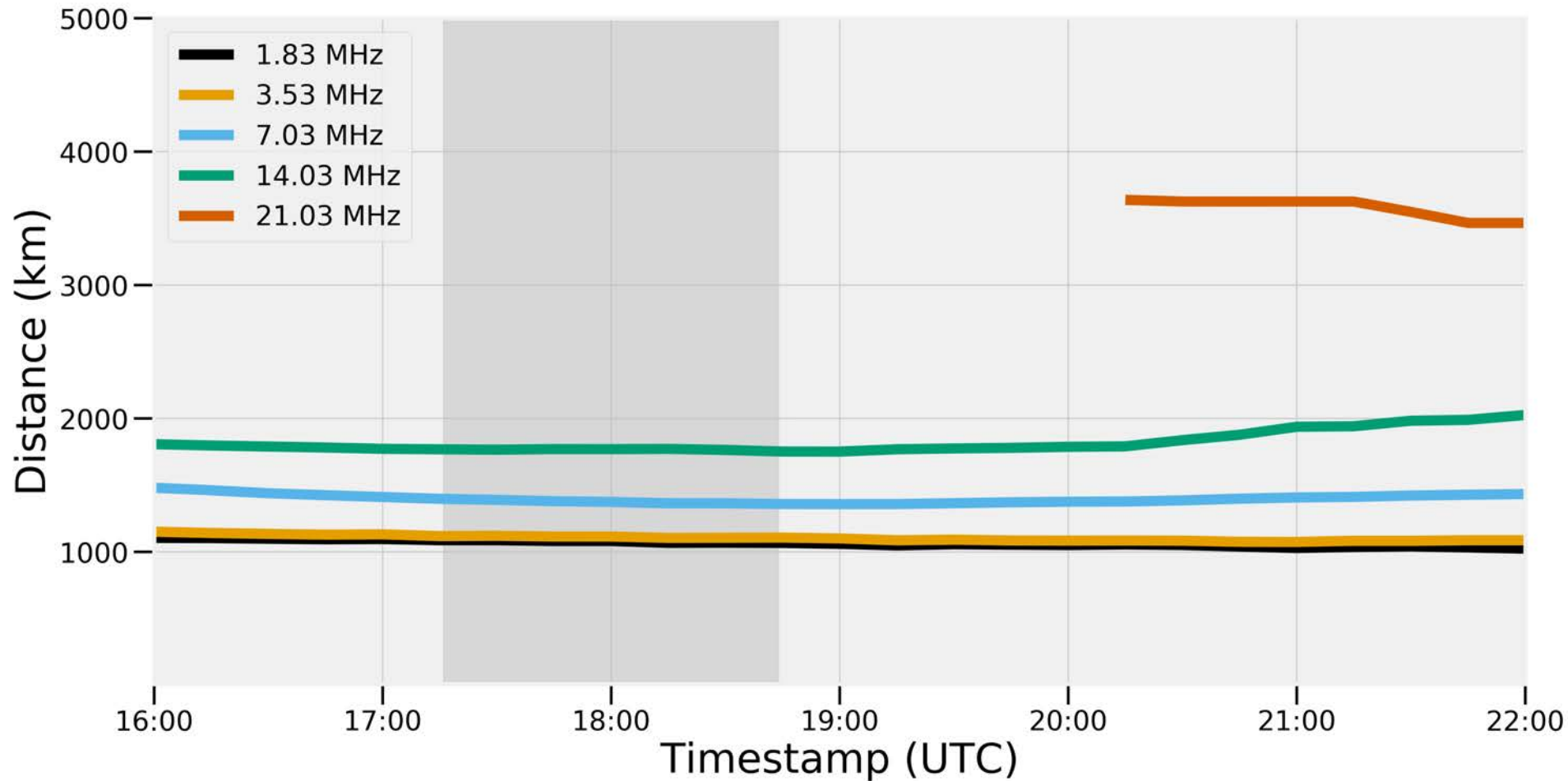
# SEQP Raytrace Simulation

## Location of Simulated Stations



# Non-Eclipse Simulated Skip Distance

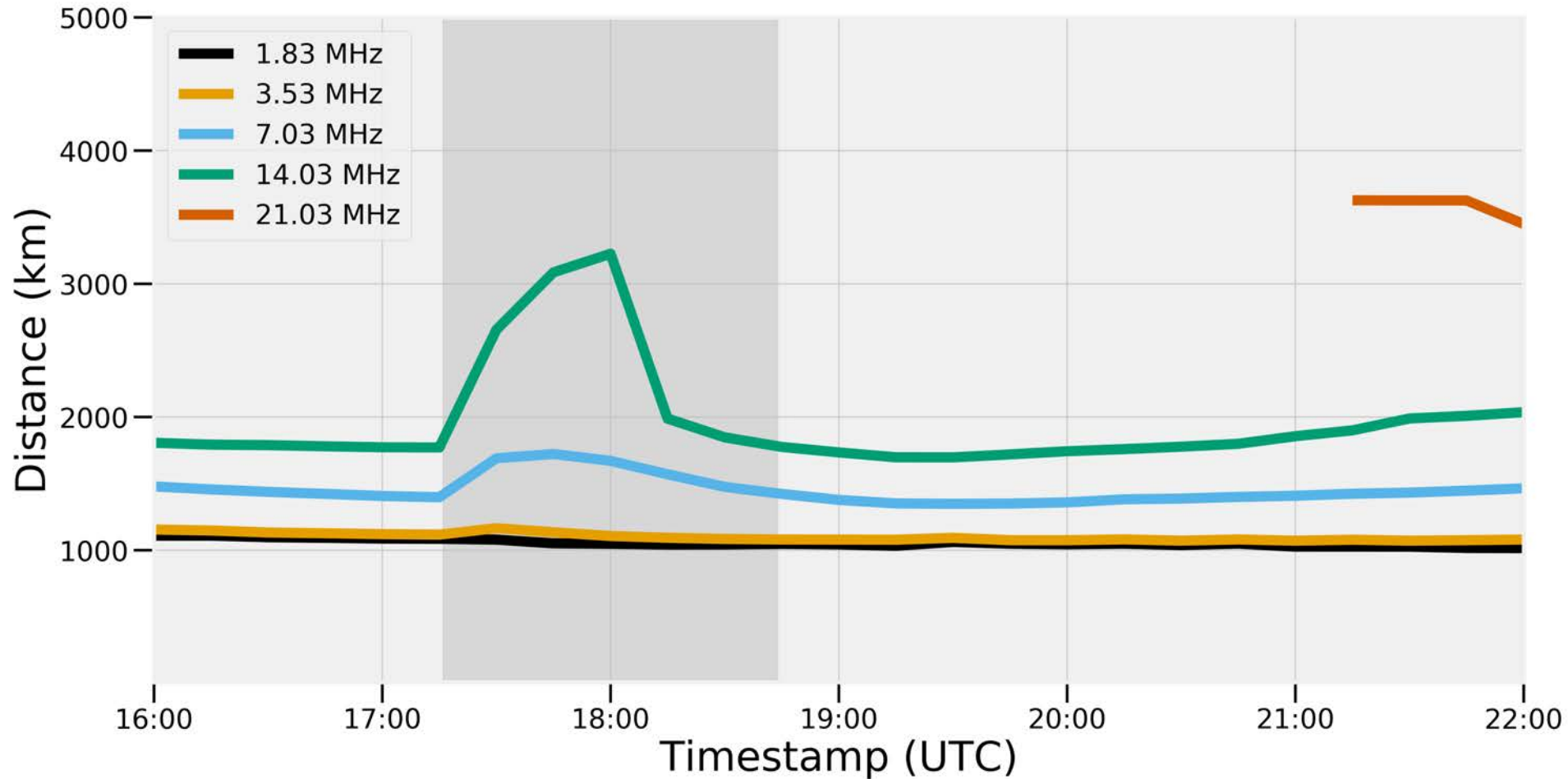
Simulated Median "Hop" Ground Distance (Base)





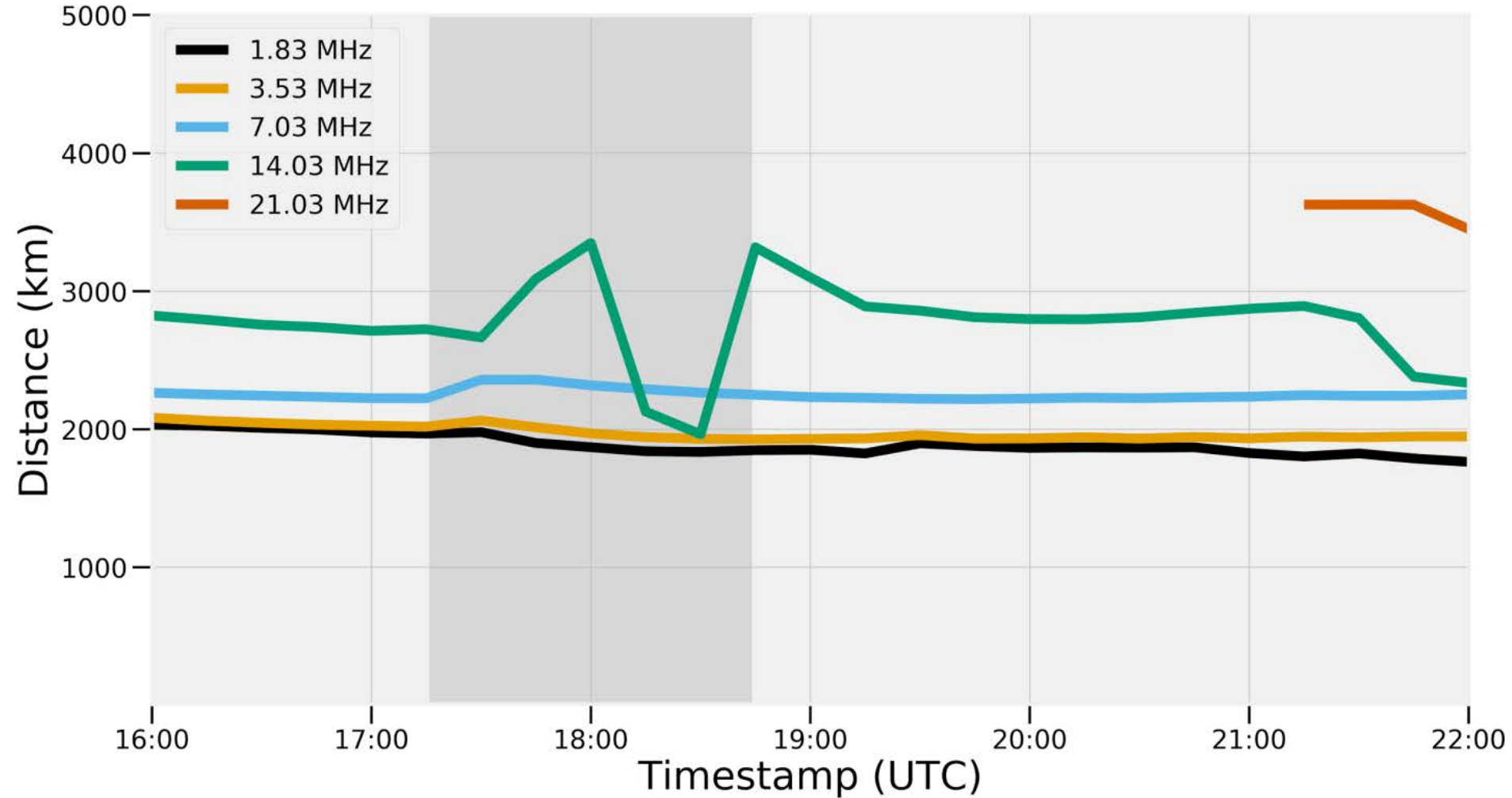
# Eclipse Simulated Skip Distance

Simulated Median "Hop" Ground Distance (Eclipse)



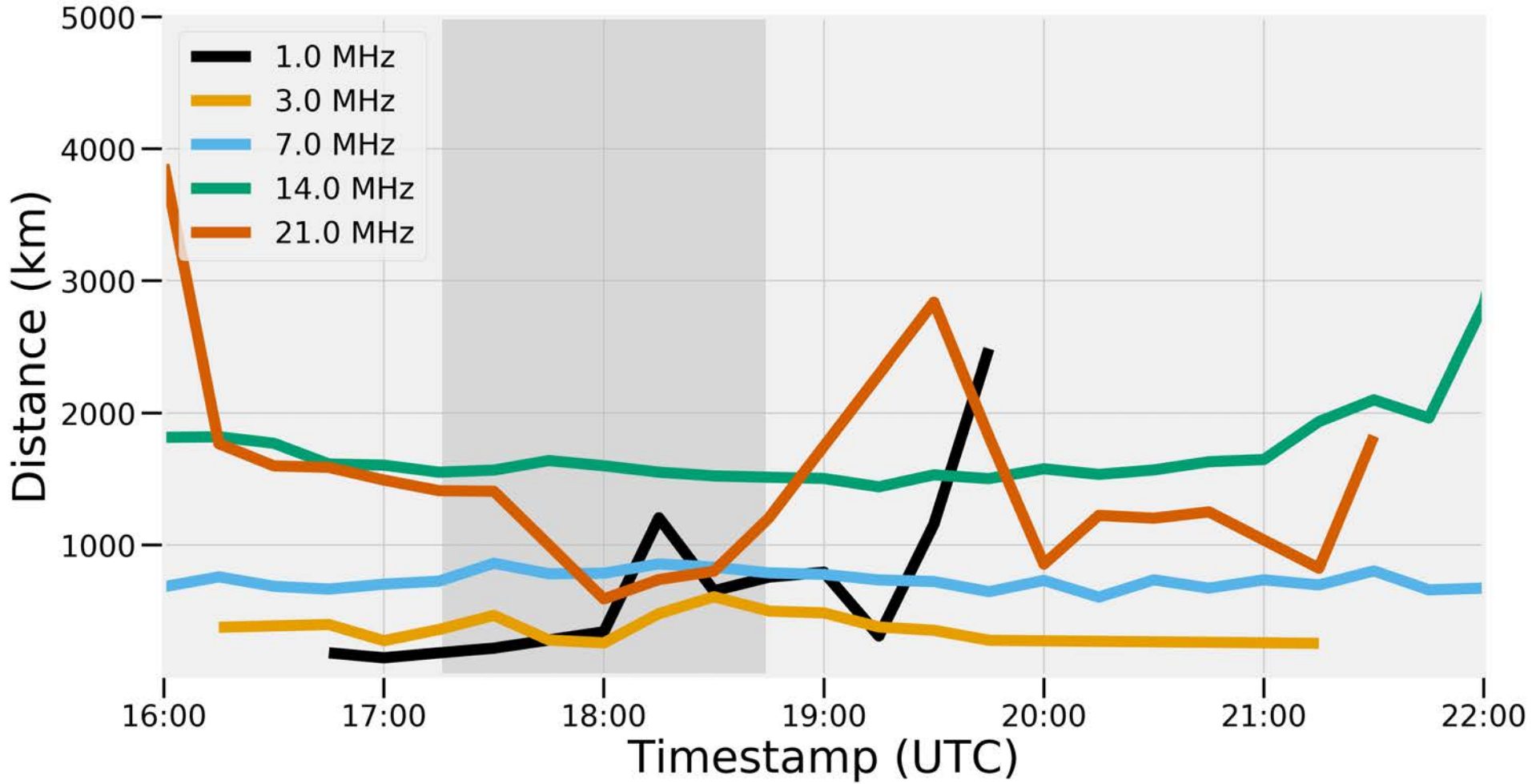
# Eclipse Simulated QSO Distance

Simulated Median QSO Distance (Eclipse)



# SEQP Observed Median QSO Distance

SEQP Median QSO Distance



# Summary

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- **Ham Radio Science Citizen Investigation**

- An organization that allows university researchers to collaborate with the amateur radio community in scientific investigations.

- **DX Display / HARC Database**

- HamSCI is building a research database to unify RBN, PSKReporter, WSPRNet, DXCluster, and location information.

- **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

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- John Ackermann, N8UR
- David Bern, W2LNX
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- Greg Earle, W4GDE
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- Rachel Frissell, W2RUF
- 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

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Huba, J.D. and D. Drob, “SAMI3 prediction of the impact of the 21 August 2017 total solar eclipse on the ionosphere/plasmasphere system,” *Geophysical Research Letters*, vol. 44, 2017.

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](mailto: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

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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](http://hamsci.org) and ARRL news for details.*



# Thank you!

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