NJIT New Jersey Institute of Technology

HamSCI

HamSCI and the 2017 Total Solar Eclipse

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Outline

I. What is Ham Radio & HamSCI?

II. Eclipse Experiments
   I. 2017 Total Solar Eclipse & The Ionosphere
   II. Ham Radio Data Sources
   III. Observations & Discussion

III. Results & Summary

Amateur/Ham Radio

- Hobby for Radio Enthusiasts
  - Communicators
  - Builders
  - Experimenters
- Wide-reaching Demographic
  - All ages & walks of life
  - Over 730,000 US hams; ~3 million World Wide

[http://www.arrl.org/arrl-fact-sheet]

HamSCI

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

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.

NJIT New Jersey Institute of Technology

Founder/Lead HamSCI Organizer:
Dr. Nathaniel A. Frissell, W2NAF
NJIT Center for Solar-Terrestrial Research

Total Solar Eclipse

21 August 2017

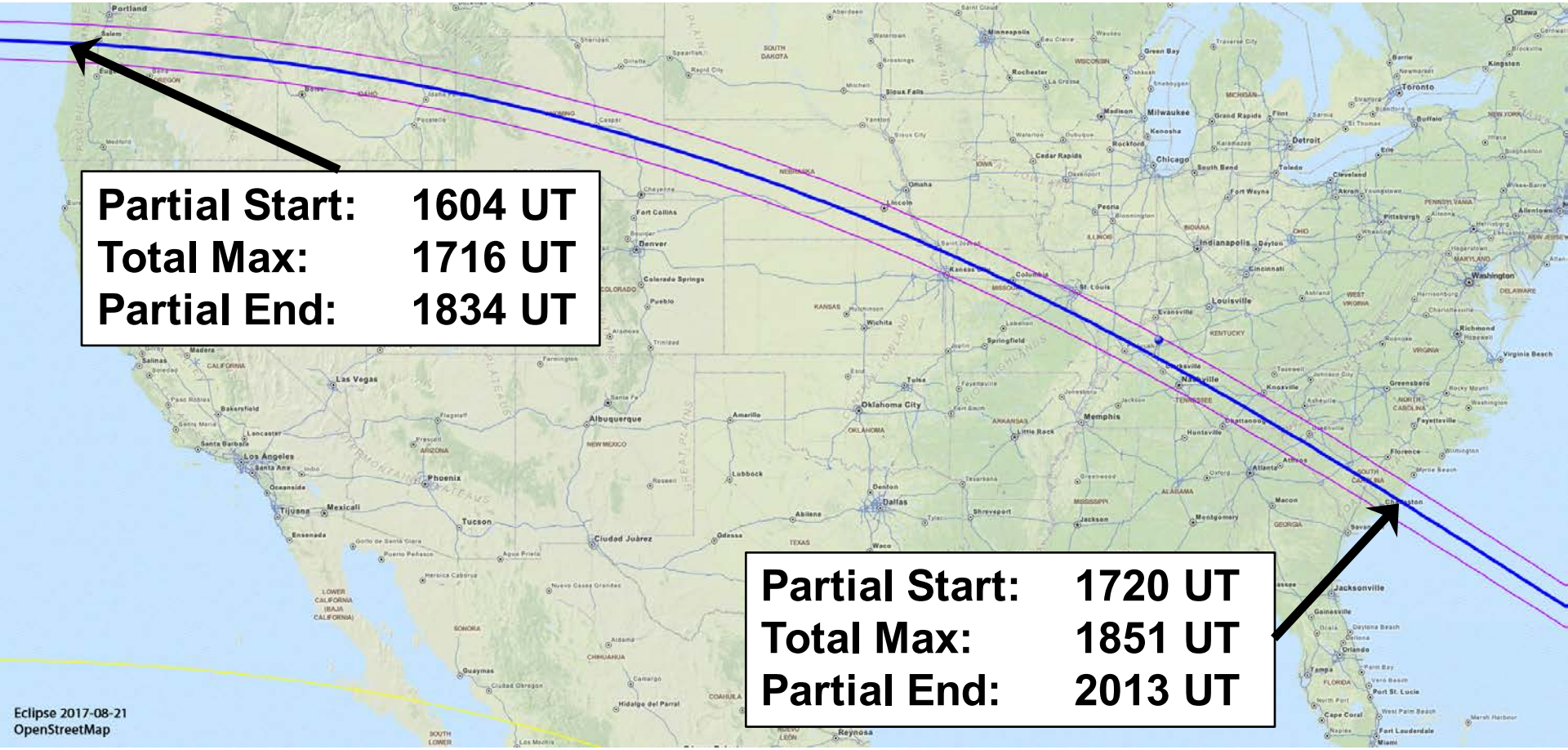
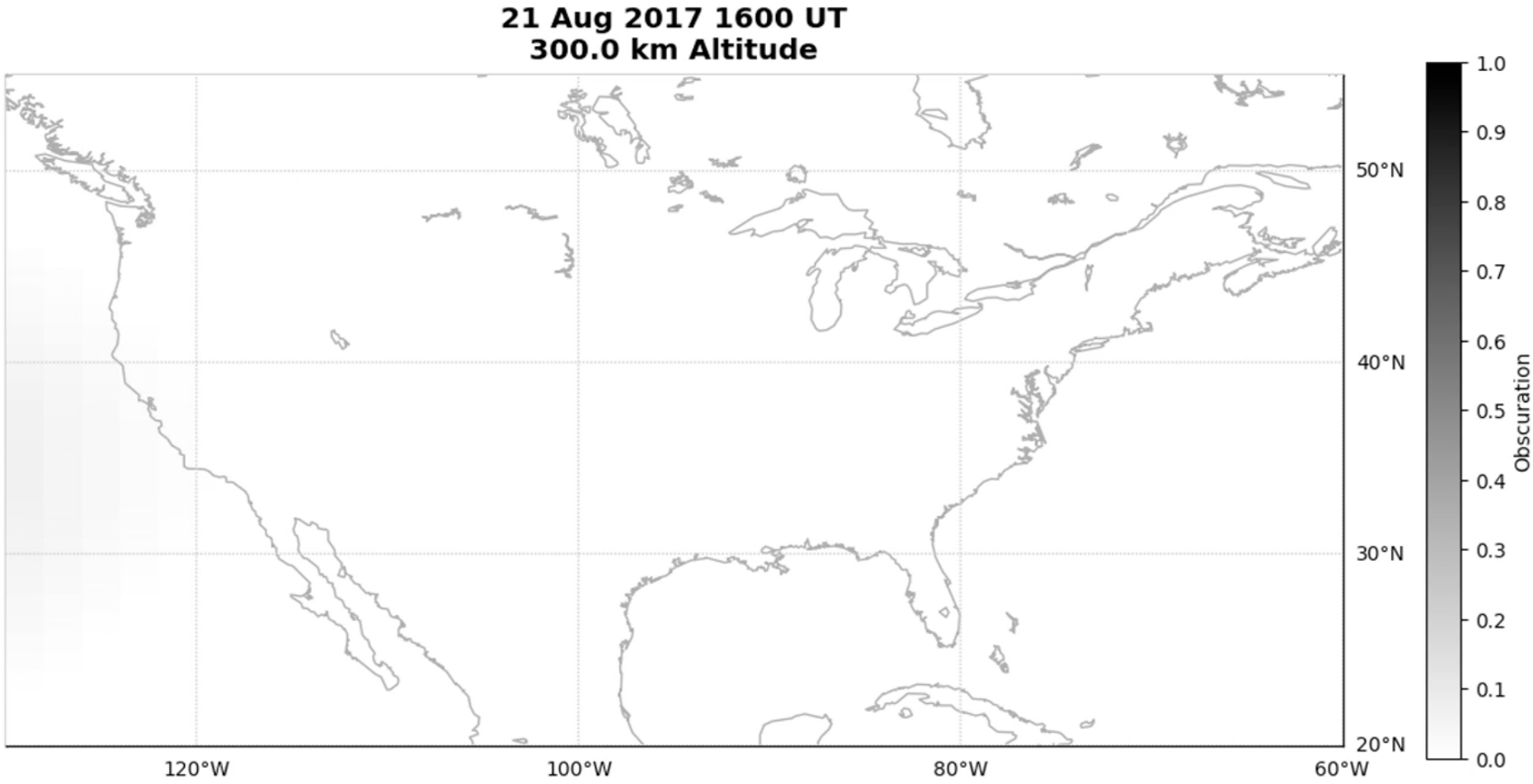


Figure: W. Strickling, Wikipedia

Eclipse Obscuration



Solar Eclipse Ionospheric Effects?

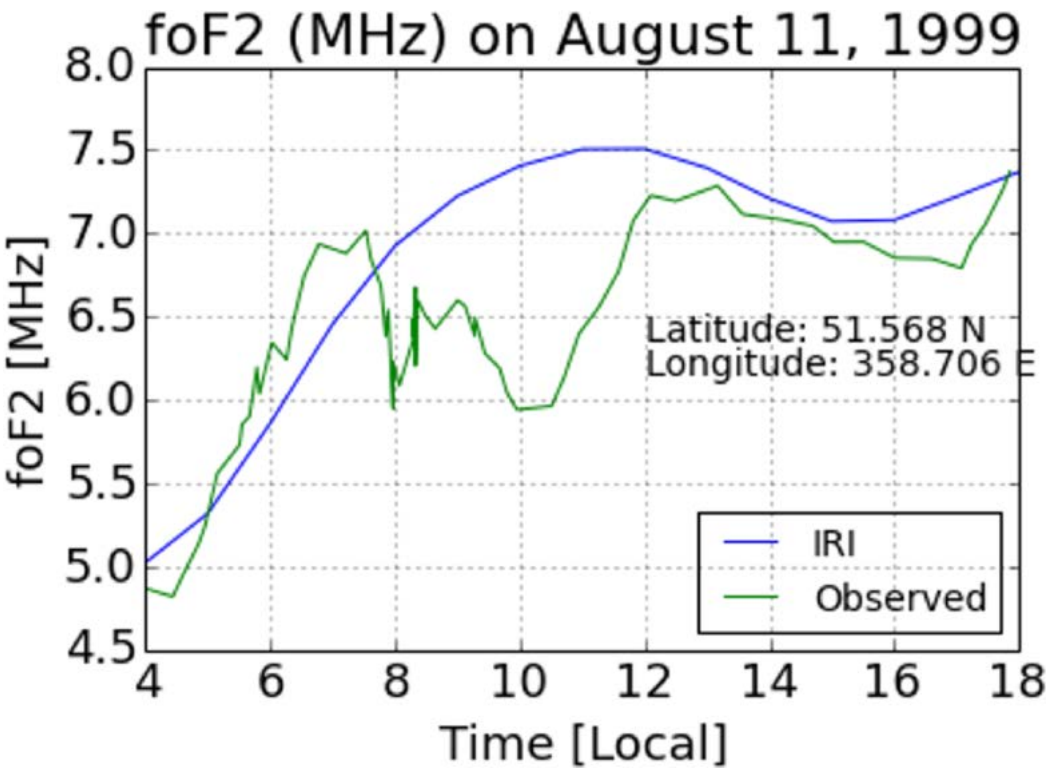
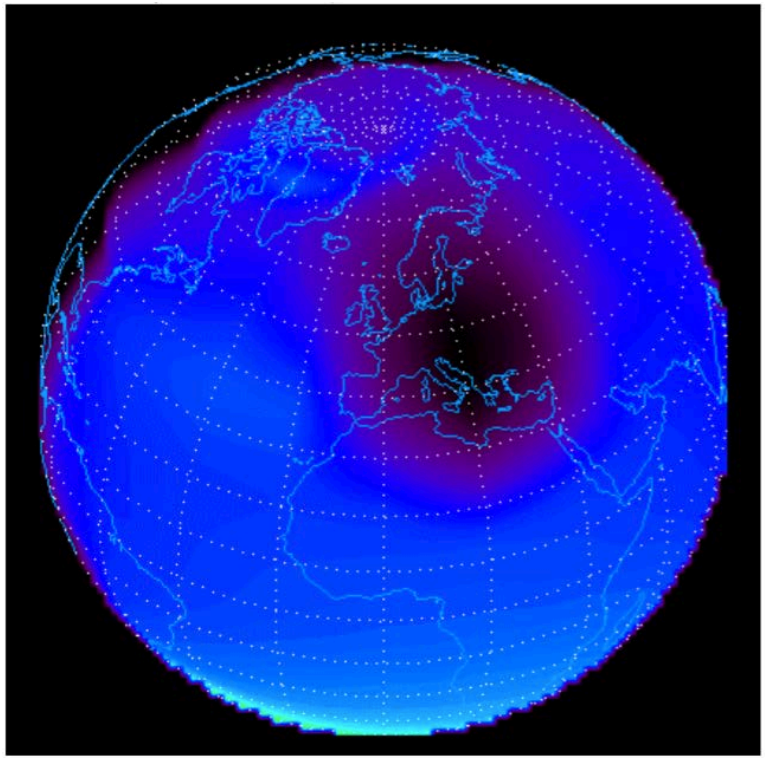


Figure: M. Moses after *Afraimovich et al.*, 2002



Model Electron Density at ~280 km alt. during 1999 Eclipse
M. Harris from *Bamford* 2000.

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?

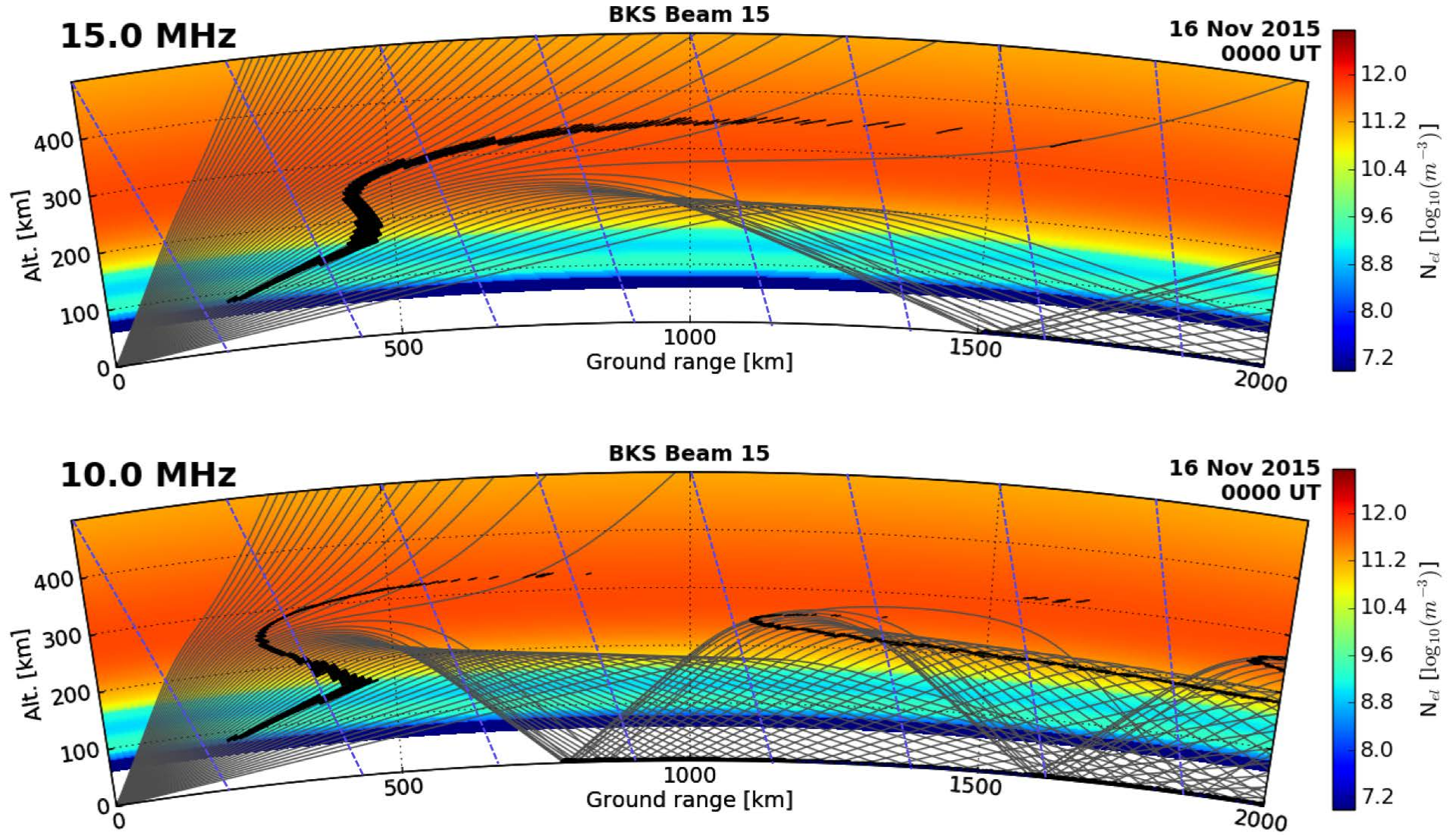
Amateur Radio and the HF Bands

Frequency	Wavelength
1.8 MHz	160 m
3.5 MHz	80 m
7 MHz	40 m
10 MHz	30 m
14 MHz	20 m
18 MHz	17 m
21 MHz	15 m
24 MHz	12 m
28 MHz	10 m
50 MHz	6 m

K2MFF, The NJIT Ham Radio Station

- Hobbyists routinely use HF-VHF transionospheric links.
- Often ~100 W into dipole antennas.

HF Propagation & The Ionosphere

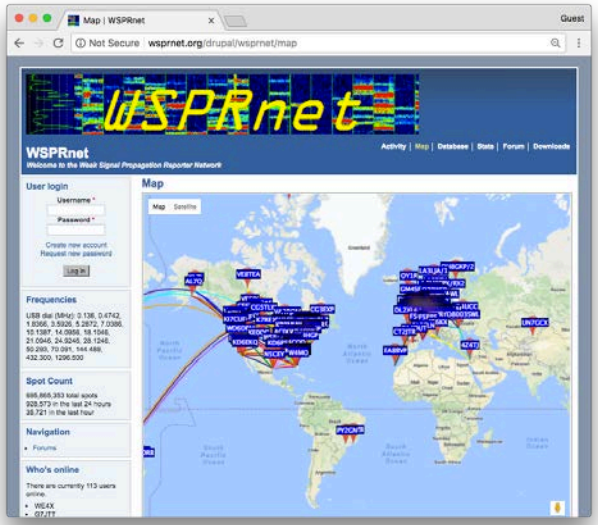


HamSCI Eclipse Experiments

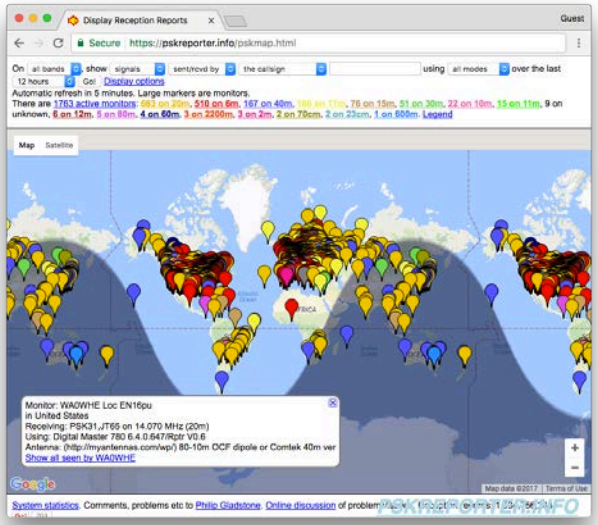
- **Solar Eclipse QSO Party (SEQP)**
  - Ham Radio Contest-Like Event
  - Generate a quasi-random dataset
  - Data from RBN, PSKRepoter, WSPRNet, Logs
- **HF Wideband Recording**
  - Use SDRs to record large amounts of HF Spectrum
- **HF Frequency Measurement Experiment**
  - Measure changes in WWV, CHU frequency due to eclipse

Big Data – Ham Radio Observatories

RBN
reversebeacon.net



WSPRNet
wsprnet.org



PSKReporter
pskreporter.info

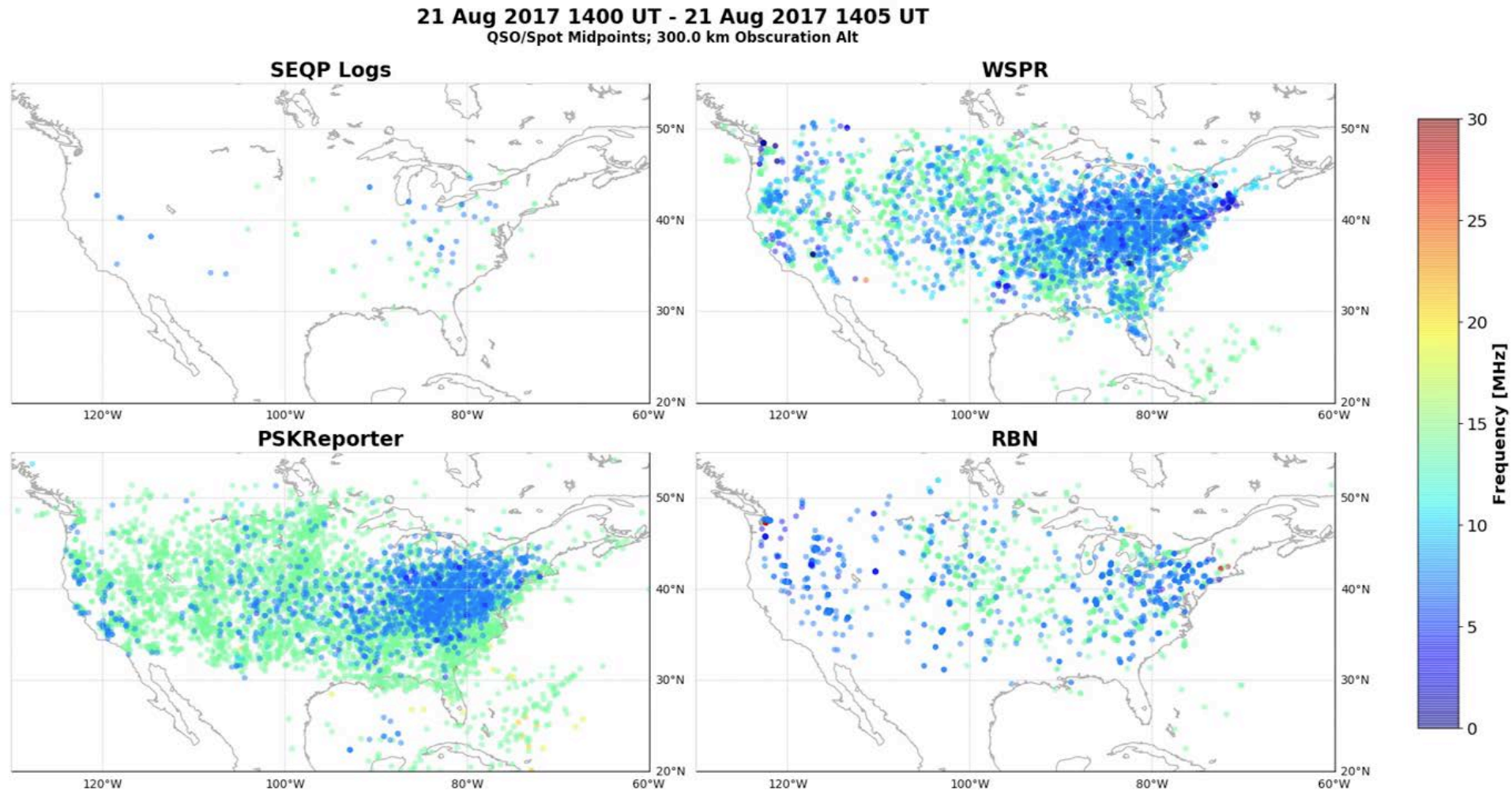
Network	Start Year	# Spots	DB Size
RBN	2009	578,000,000	36 GB
WSPRNet	2008	535,000,000	44 GB
PSKReporter	2013	1,000,000,000	100 GB

There is A LOT of data!

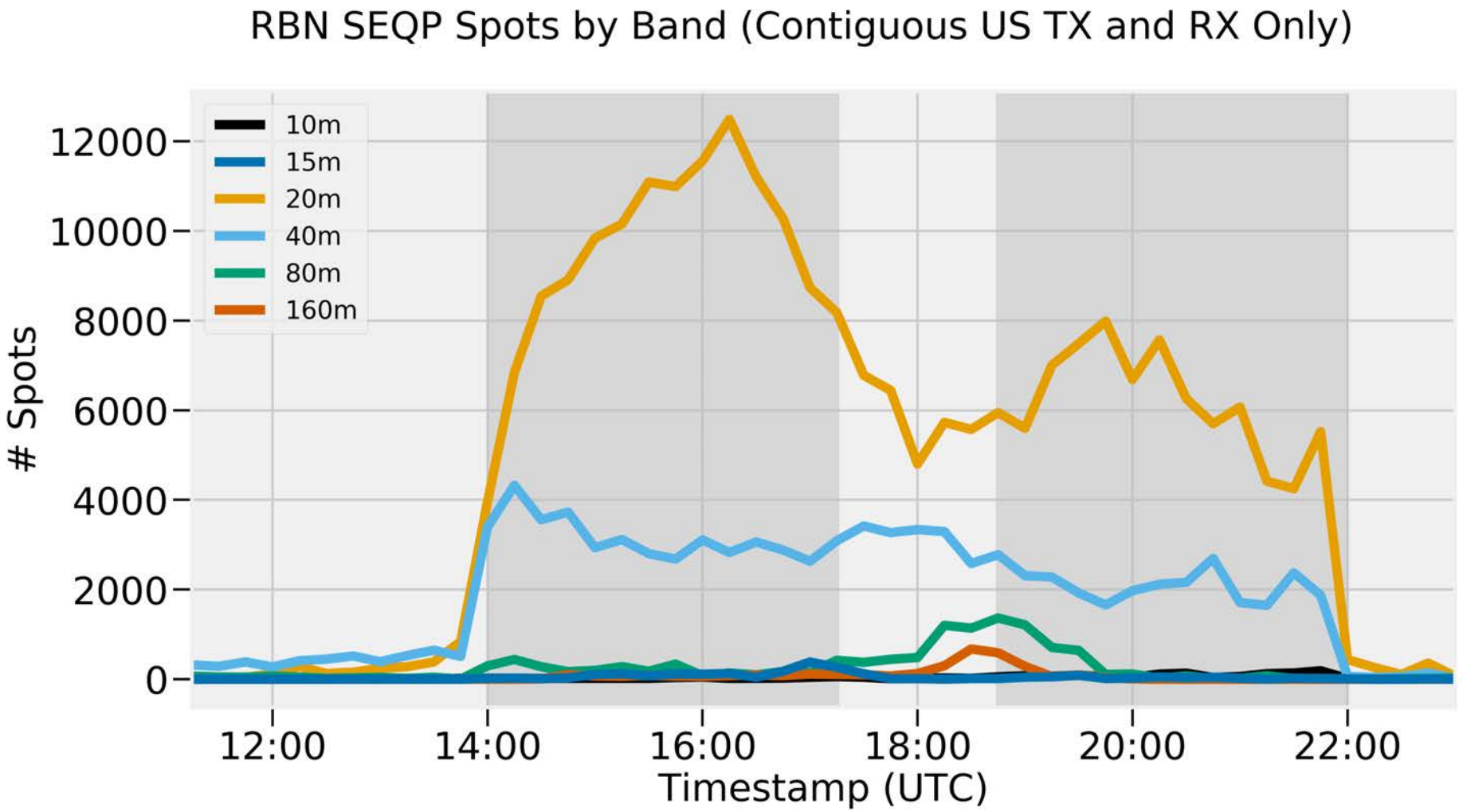
Data Collection

hamsci.org • SEQP Log Files	• 600+ Parsed Logs • 30,768 QSOs
zenodo.org HamSCI Community • Wideband Recording • Frequency Measurements	• 50+ Submissions
Reverse Beacon Network	• 618,623 Spots
PSKReporter	• 1,287,855 Spots
WSPRNet	• 630,132 Spots

Ham Radio Eclipse Data

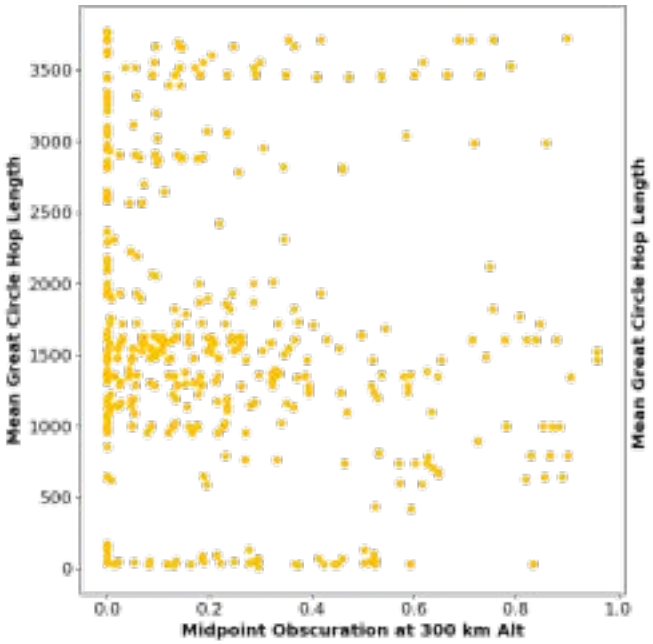


SEQP RBN Spots

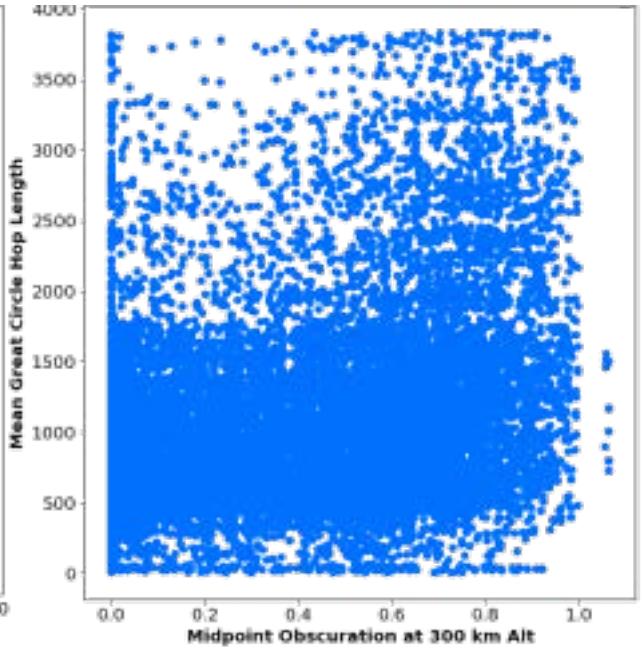


Hop Length vs. Obscuration

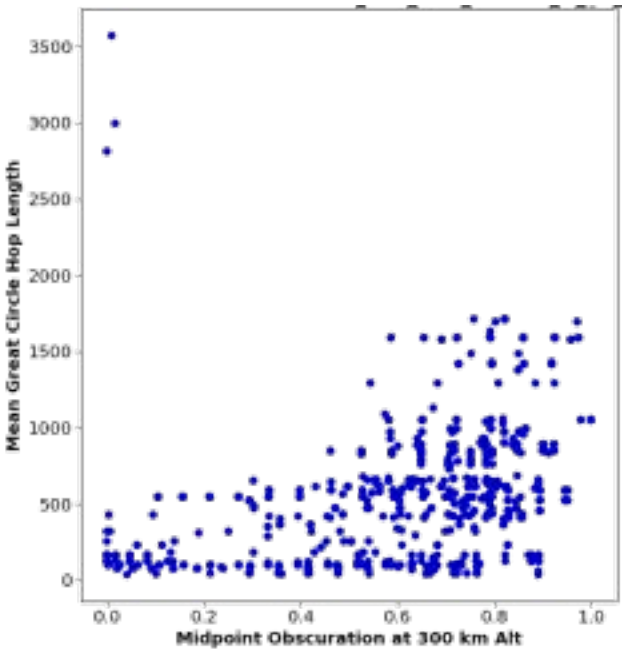
21 MHz (15 m)



7 MHz (40 m)



1.8 MHz (160 m)



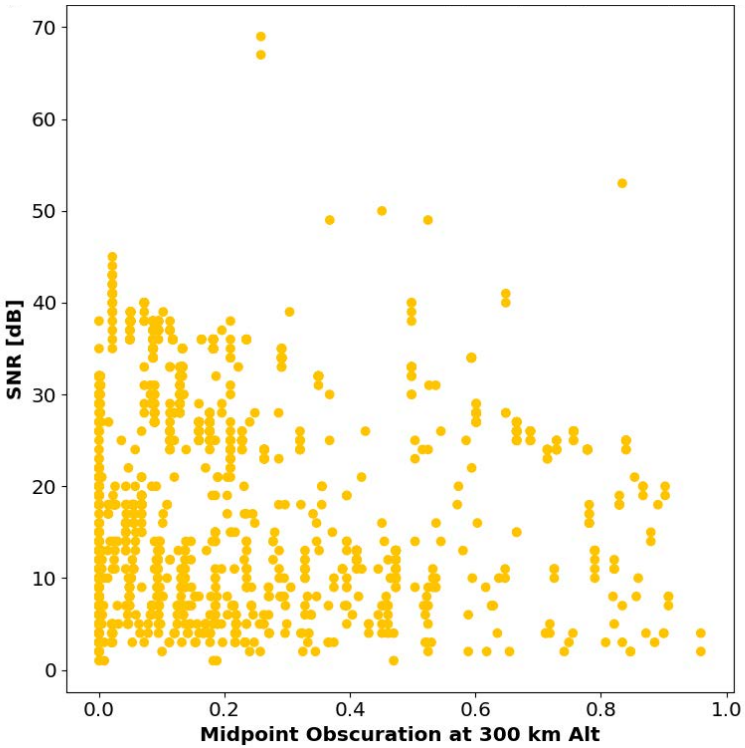
Greater Eclipse → Fewer Spots

Greater Eclipse → Longer Hops

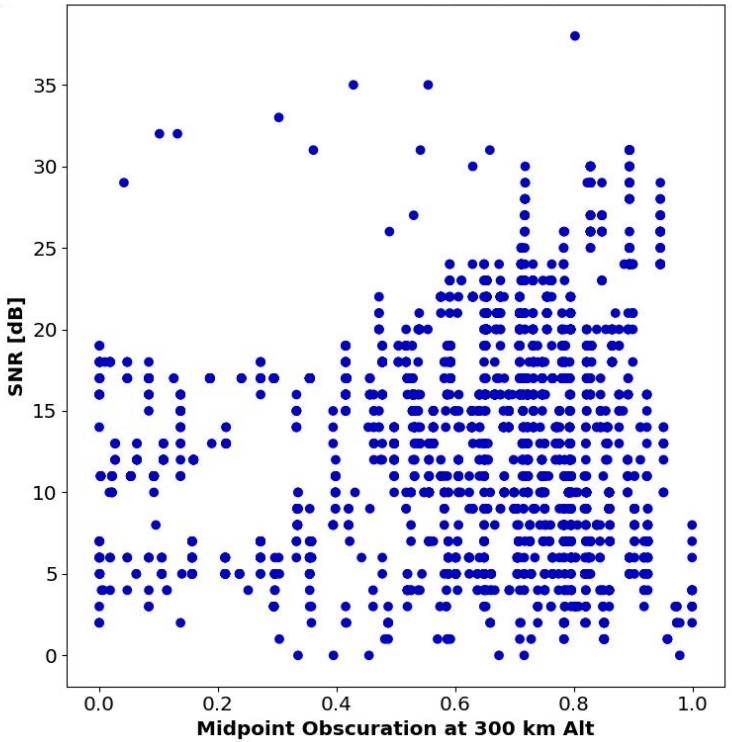
Greater Eclipse → More & Longer!

SNR vs. Obscuration

21 MHz (15 m)



1.8 MHz (160 m)



Weaker F Region →
Lower SNR, Fewer Spots

Weaker D Region →
Less Absorption, Stronger Signals, & More Spots

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
  - During Eclipse:
    - Number of 1.8 to 7 MHz Spots Increased
    - Number of 14 to 30 MHz Spots Decrease
    - Hop Lengths & SNRs increased on lower bands < 14 MHz
    - SNRs decreased on higher bands (> 14 MHz)
  - SEQP observations suggest raising of the F layer and depletion of the D layer.

Thank you!

References

Afraimovich, E.L., E.A. Kosogorov, O.S. Lesyuta (2002), Effects of the August 11, 1999 total solar eclipse as deduced from total electron content measurements at the GPS network, Journal of Atmospheric and Solar-Terrestrial Physics, Volume 64, Issue 18, Pages 1933-1941, ISSN 1364-6826, http://dx.doi.org/10.1016/S1364-6826(02)00221-3.

Bamford, R. (2000), Radio and the 1999 UK Total Solar Eclipse, Rutherford Appleton Laboratory, Chilton, Didcot, UK.