

HamSCI – The Ionosphere from your Backyard

Nathaniel A. Frissell, W2NAF

The University of Scranton

Orlando HamCation

February 8, 2020

Hams & Space Weather

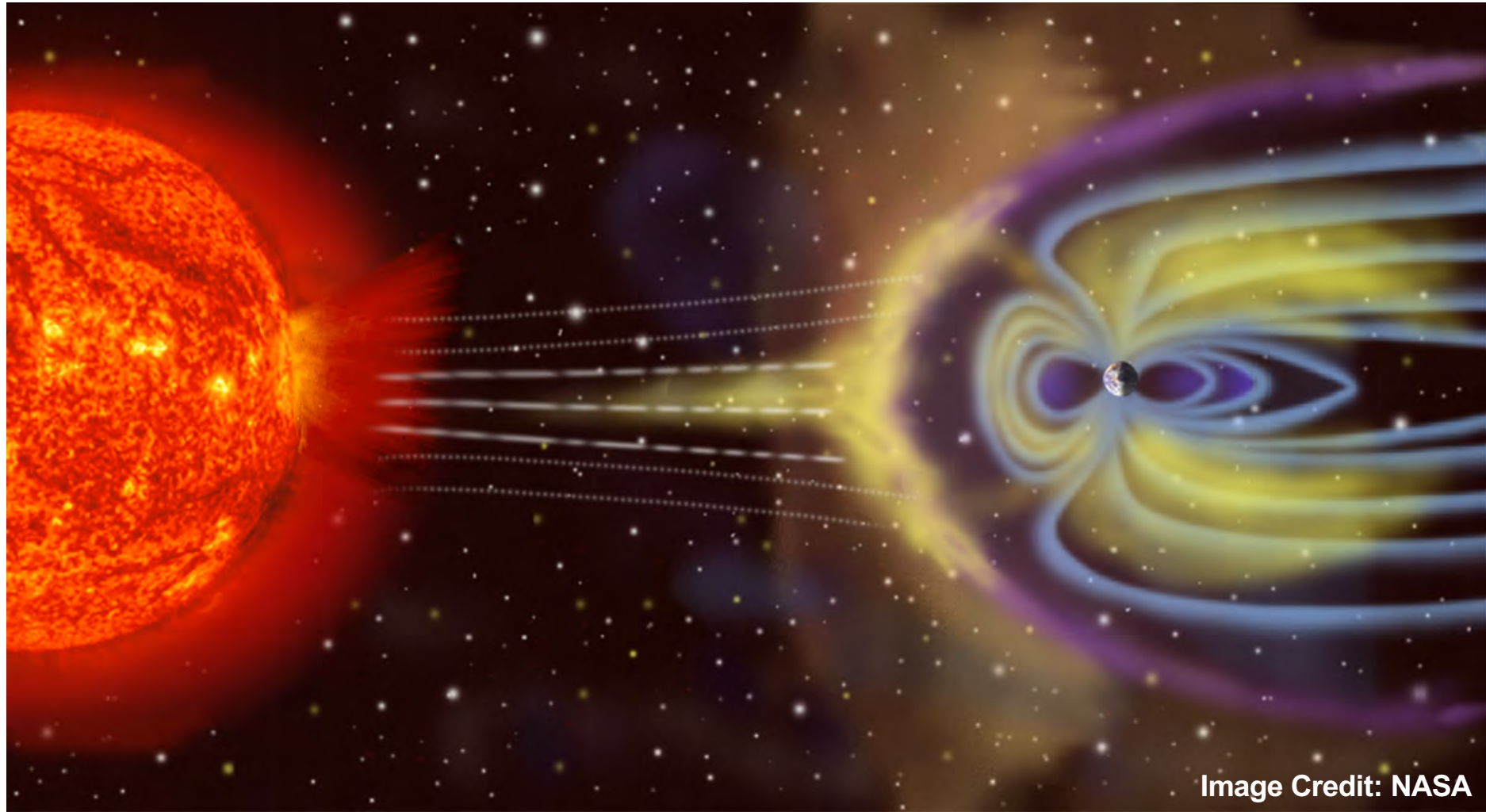
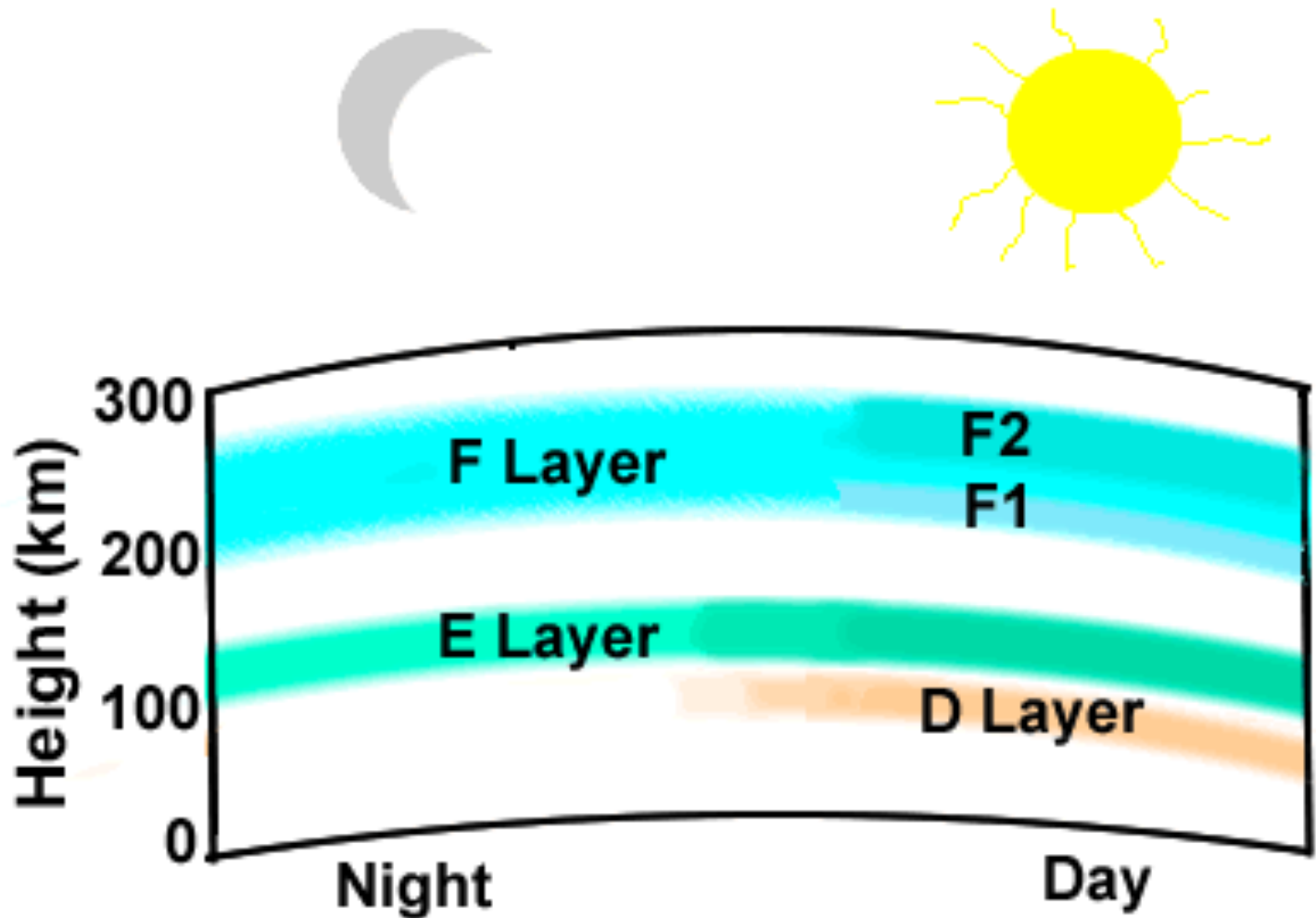


Image Credit: NASA

The Ionosphere



<https://commons.wikimedia.org/wiki/File:IonosphereLayers-NPS.gif>

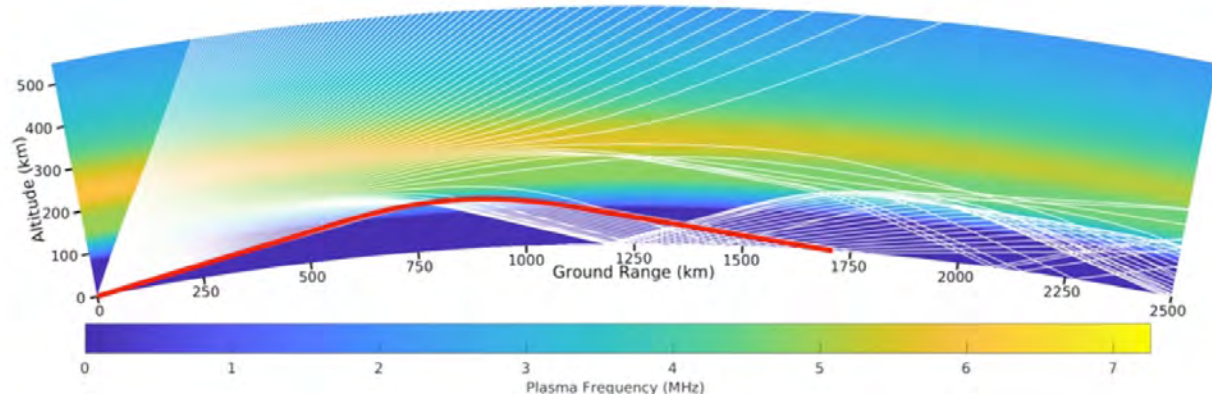
Skywave Propagation

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

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

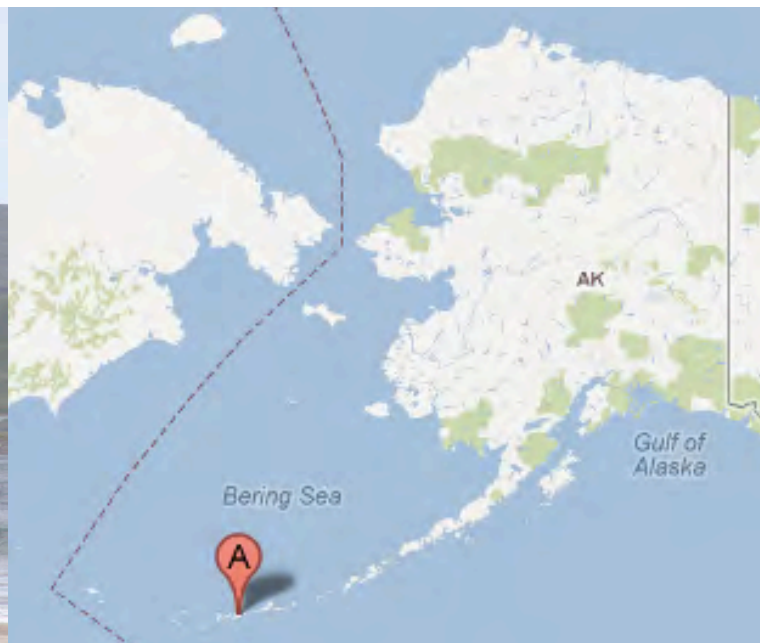


*K2MFF, The NJIT
Ham Radio
Station*

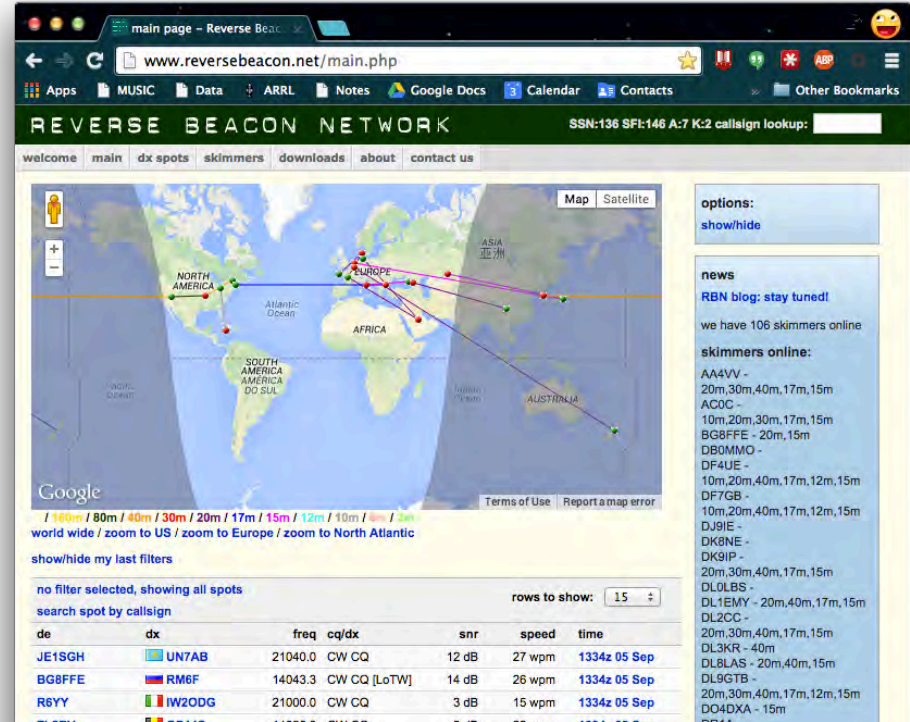
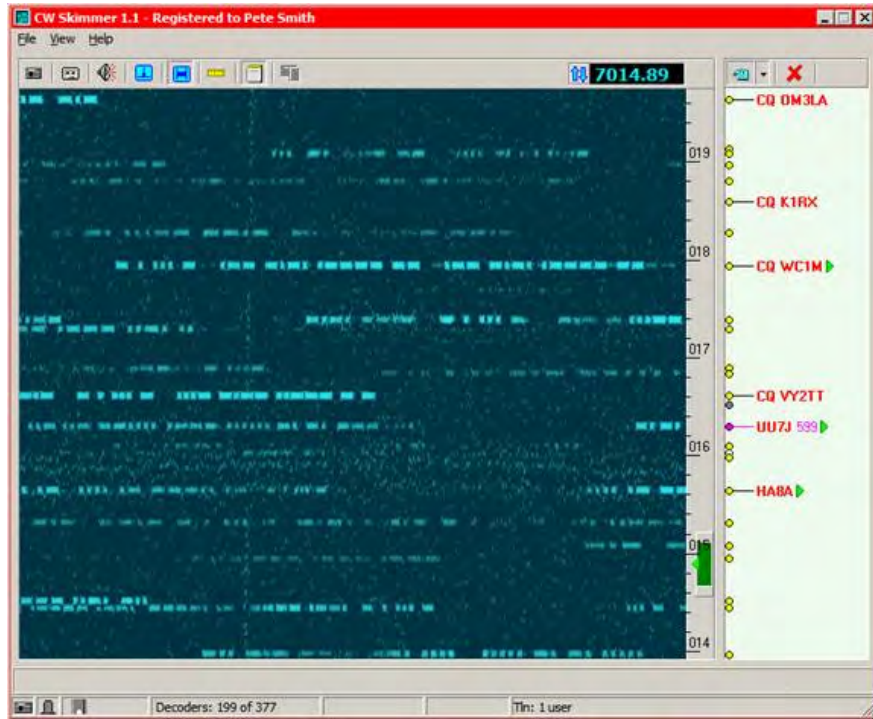


**1600 UT 21 Aug 2017 14.03 MHz - Eclipsed SAMI3
TX: AA2MF (Florida) RX: WE9V (Wisconsin)**

Adak Island SuperDARN/DXPedition



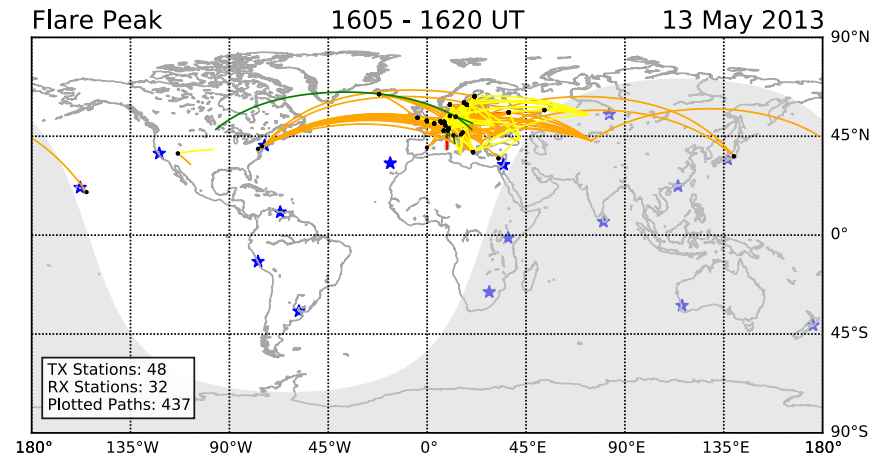
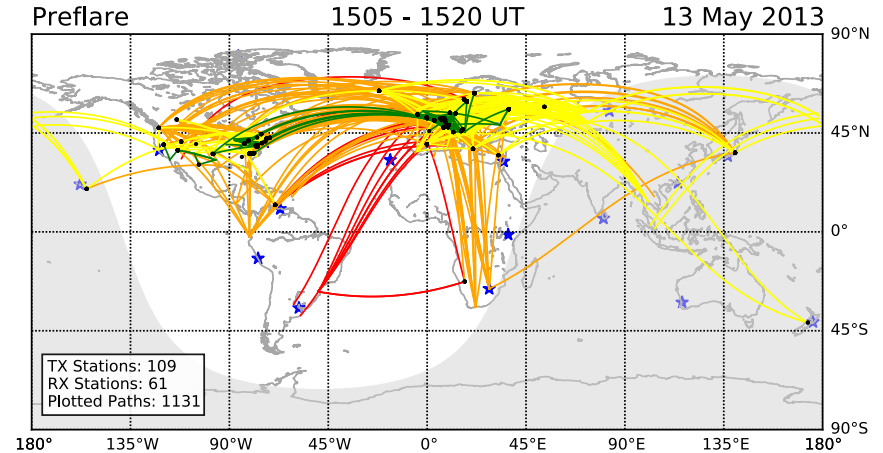
CW Skimmer and RBN



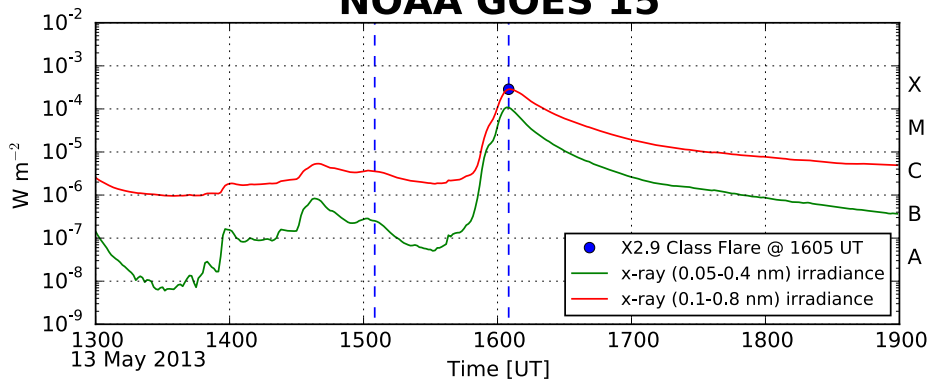
RBN/PSKReporter/WSPRNet RX



Reverse Beacon Network Solar Flare HF Communication Paths



NOAA GOES 15



[Frissell et al., 2014, Space Weather]

2017 Total Solar Eclipse

21 August 2017

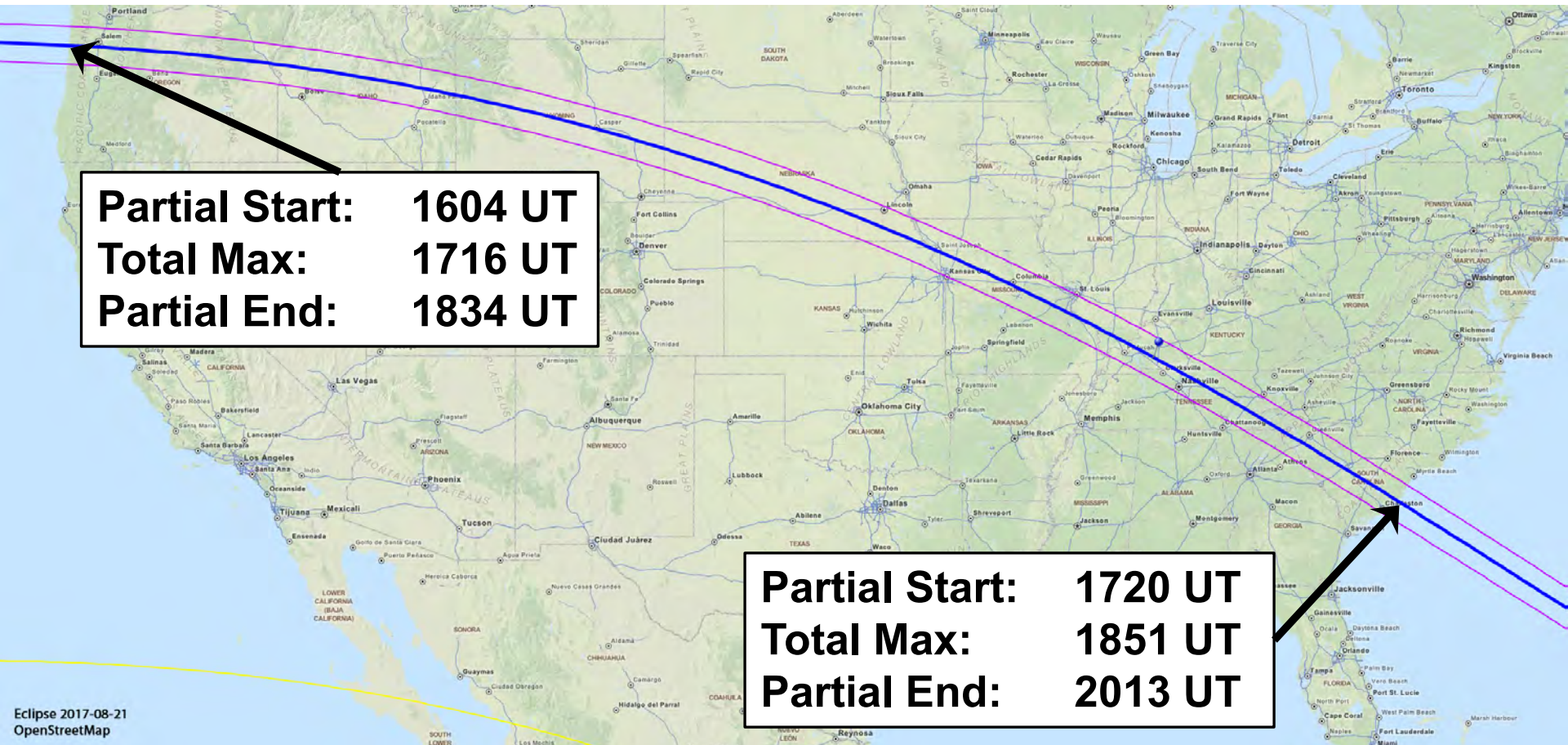


Figure: W. Strickling, Wikipedia

HamSCI Eclipse Research Questions

- Can we use HF ham radio communications to observe eclipse effects on the ionosphere?
- Can we use data-model comparisons to:
 - Better understand the ham radio data?
 - Constrain or calibrate the model?



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>

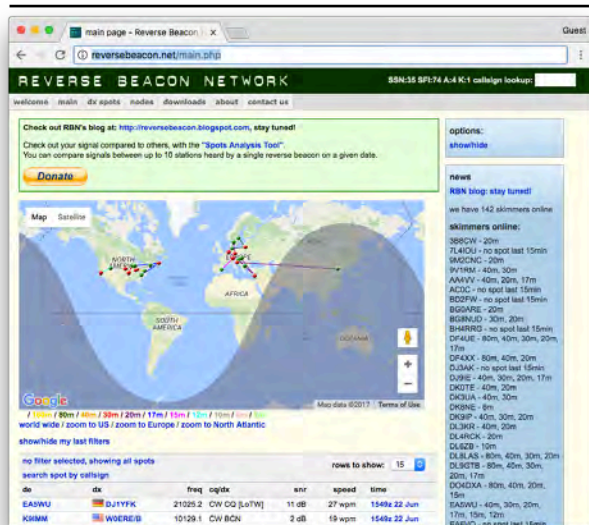
Solar Eclipse QSO Party

- 570 parsed logs
- 29,809 QSOs
- 4,929 unique callsigns
- 649 4-char grid squares
- 80 DX Entities

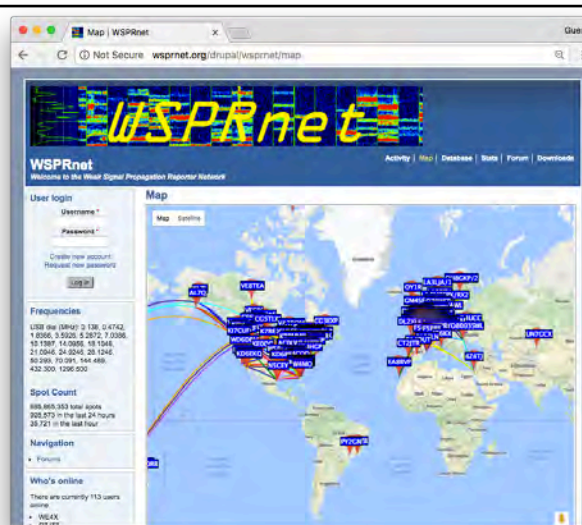
(from logs submitted to hamsci.org)



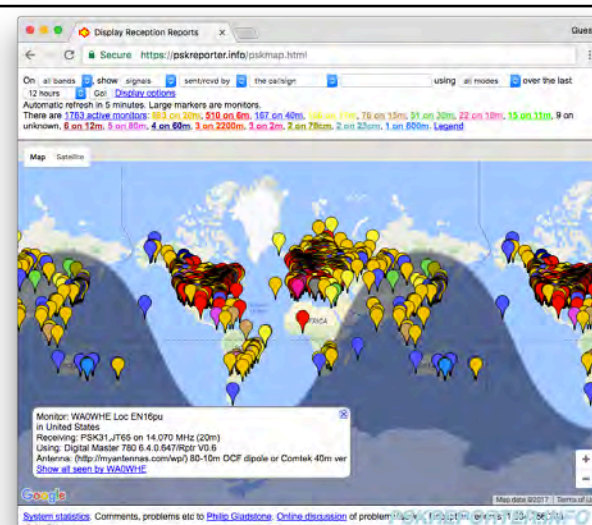
SEQP Observations



RBN
reversebeacon.net



WSPRNet
wspnnet.org

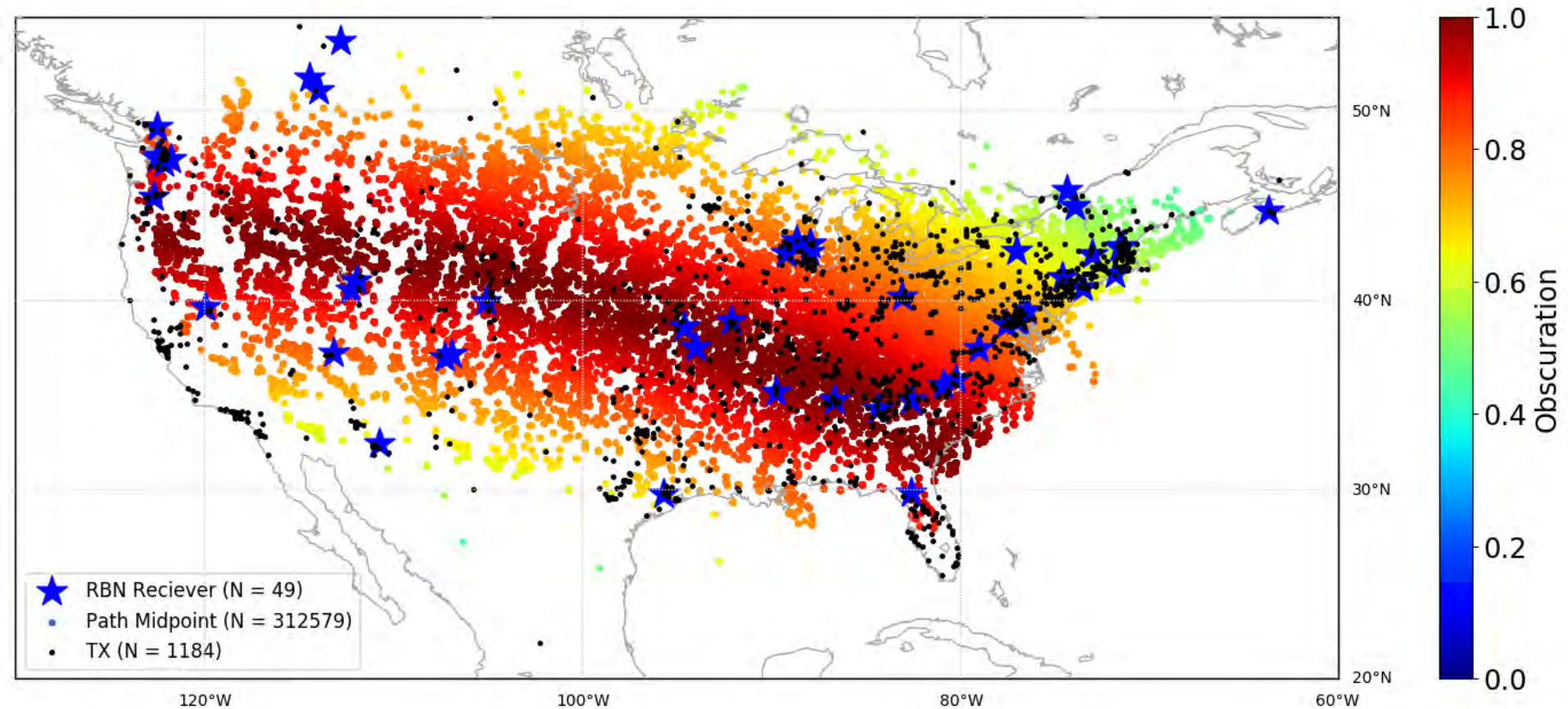


PSKReporter
pskreporter.info

Observations from 21 August 2017 1400 – 2200 UT

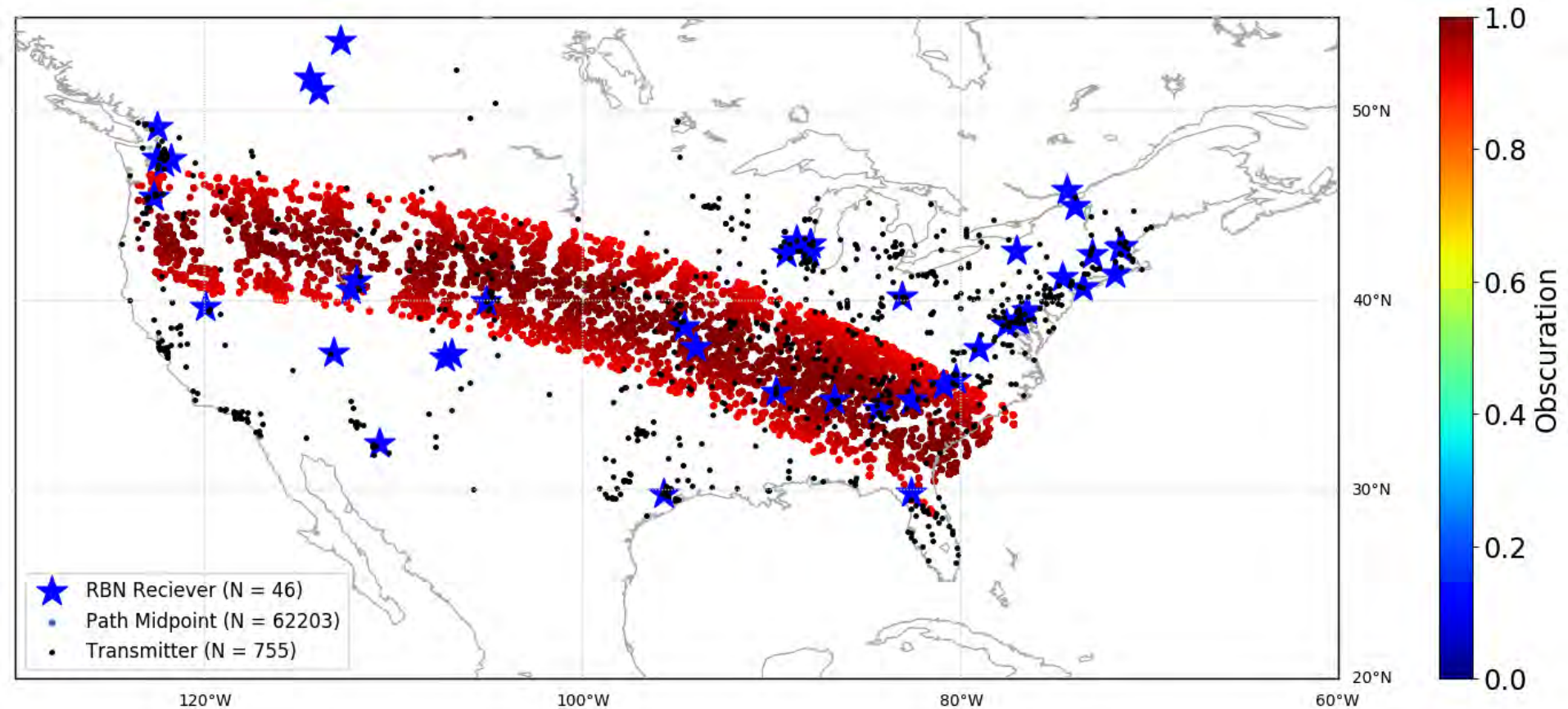
Network	# Spots / QSOs
RBN	618,623
WSPRNet	630,132
PSKReporter	1,287,962
Participant Logs	29,809

SEQP RBN Observations



[Frissell et al., 2018]

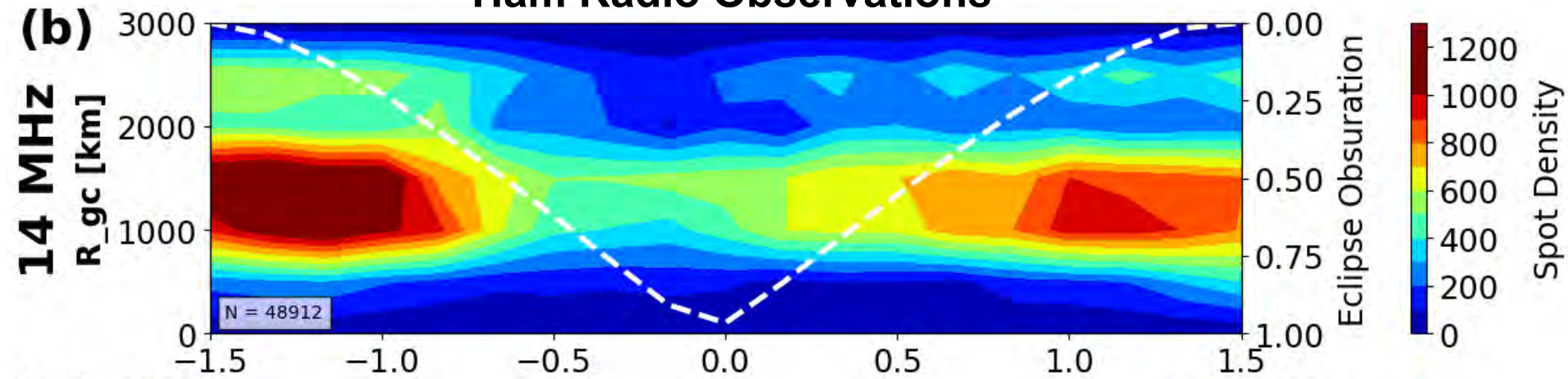
SEQP RBN ($O_{300} \geq 0.9$)



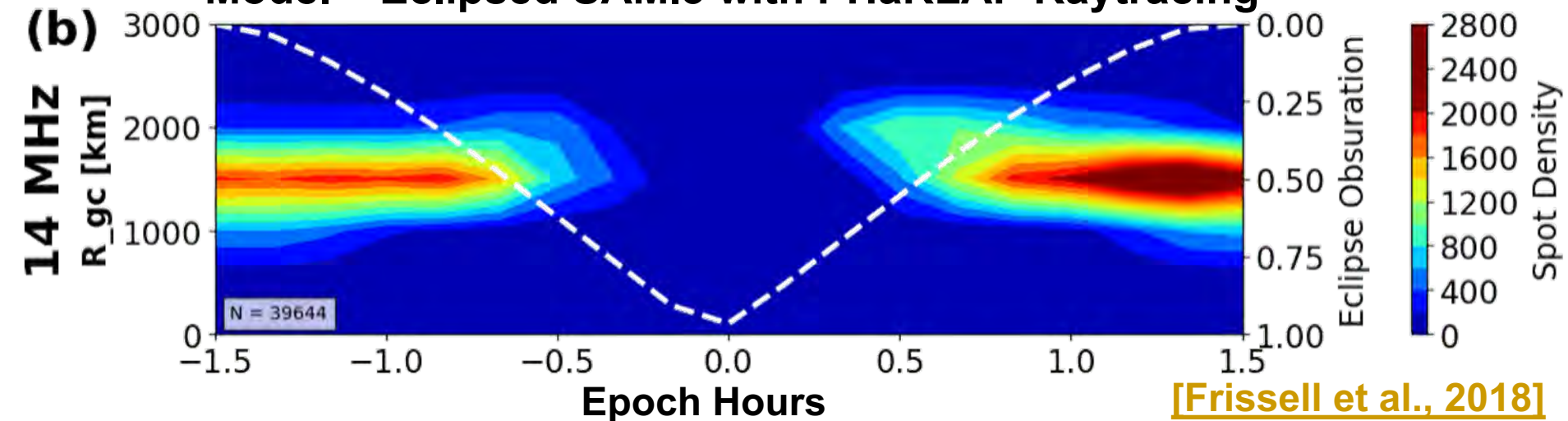
[Frissell et al., 2018]

14 MHz SEQP RBN ($O_{300} \geq 0.9$)

Ham Radio Observations

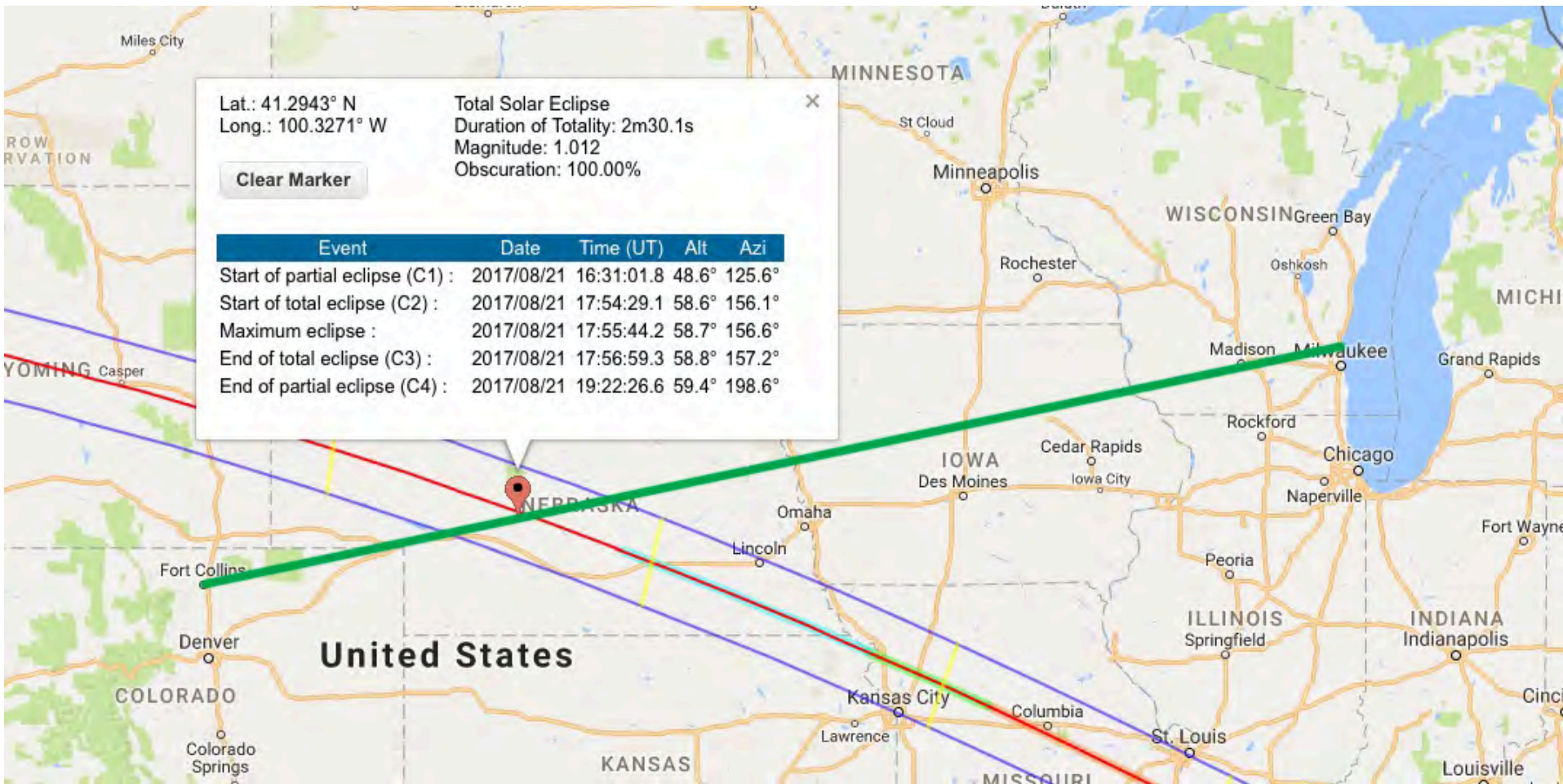


Model – Eclipsed SAMI3 with PHaRLAP Raytracing



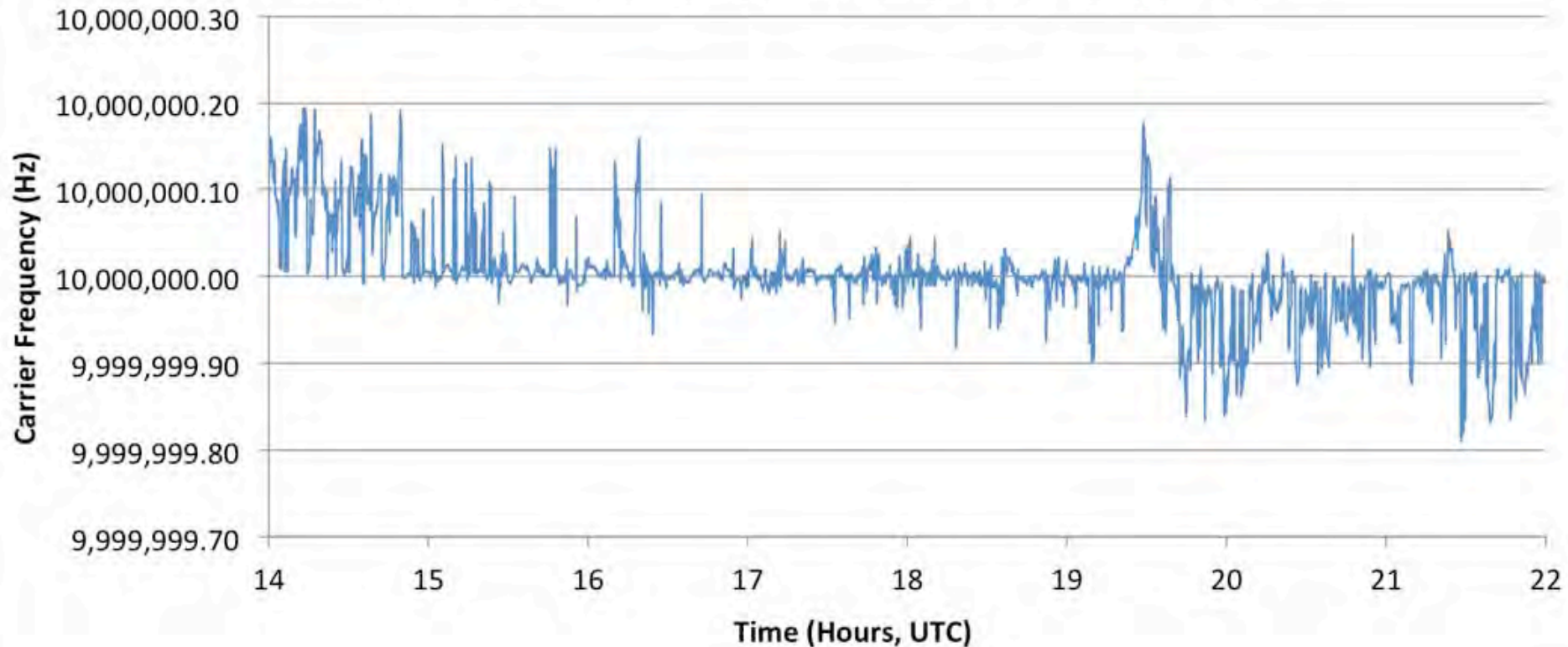
[Frissell et al., 2018]

WA9VNJ 10MHz WWV Observations

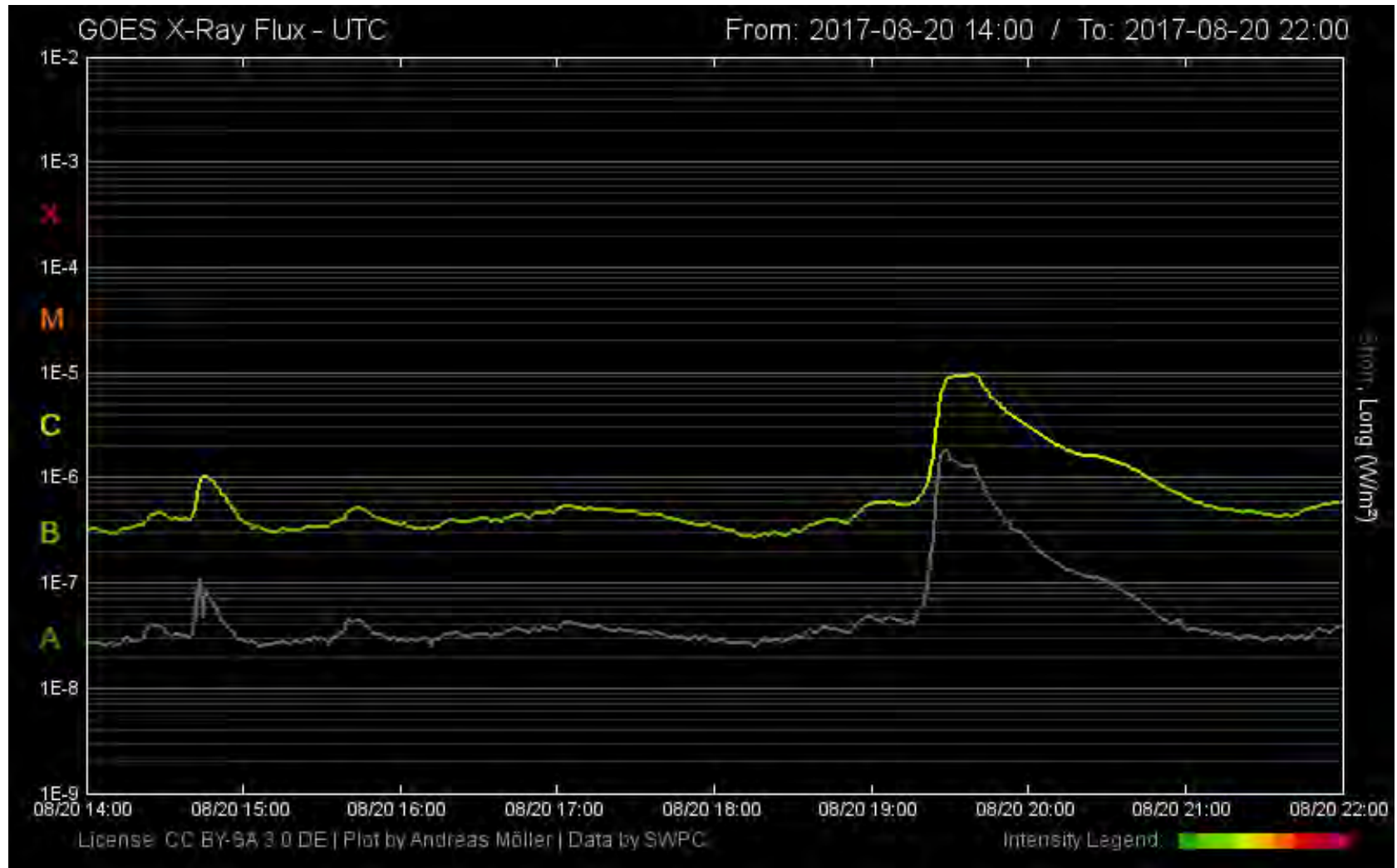


WA9VNJ 10MHz WWV Observations

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



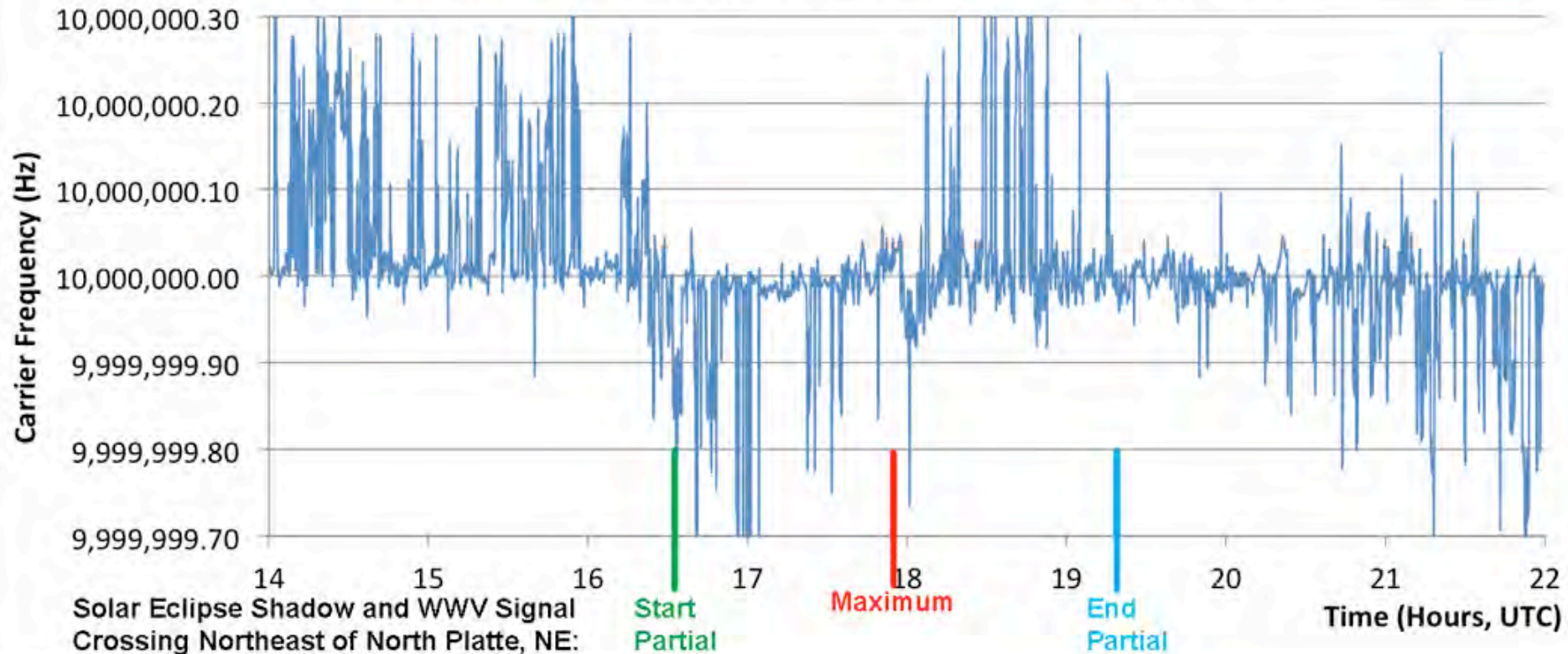
GOES X-Ray Flux – Control Day



http://www.polarlicht-vorhersage.de/goes_archive

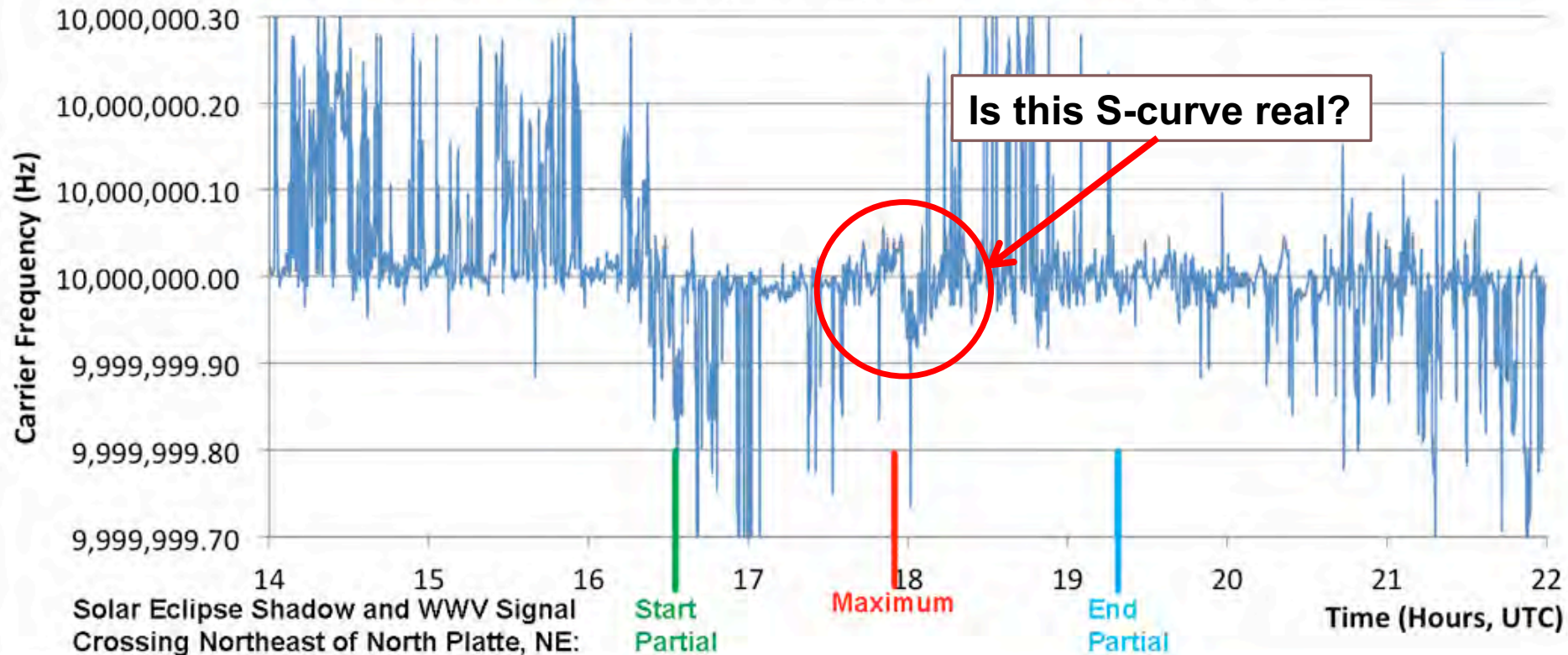
WA9VNJ 10MHz WWV Observations

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

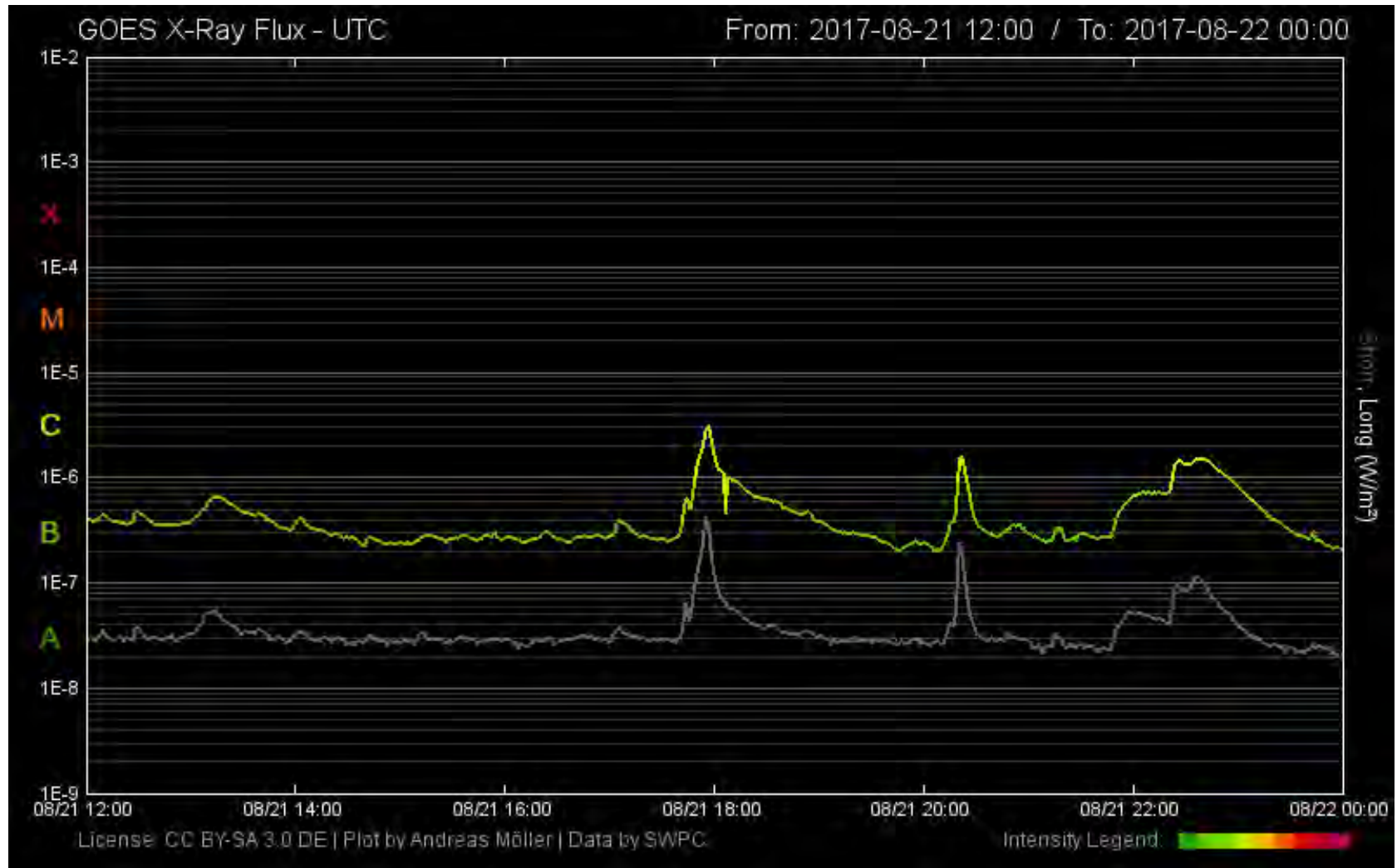


WA9VNJ 10MHz WWV Observations

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



GOES X-Ray Flux

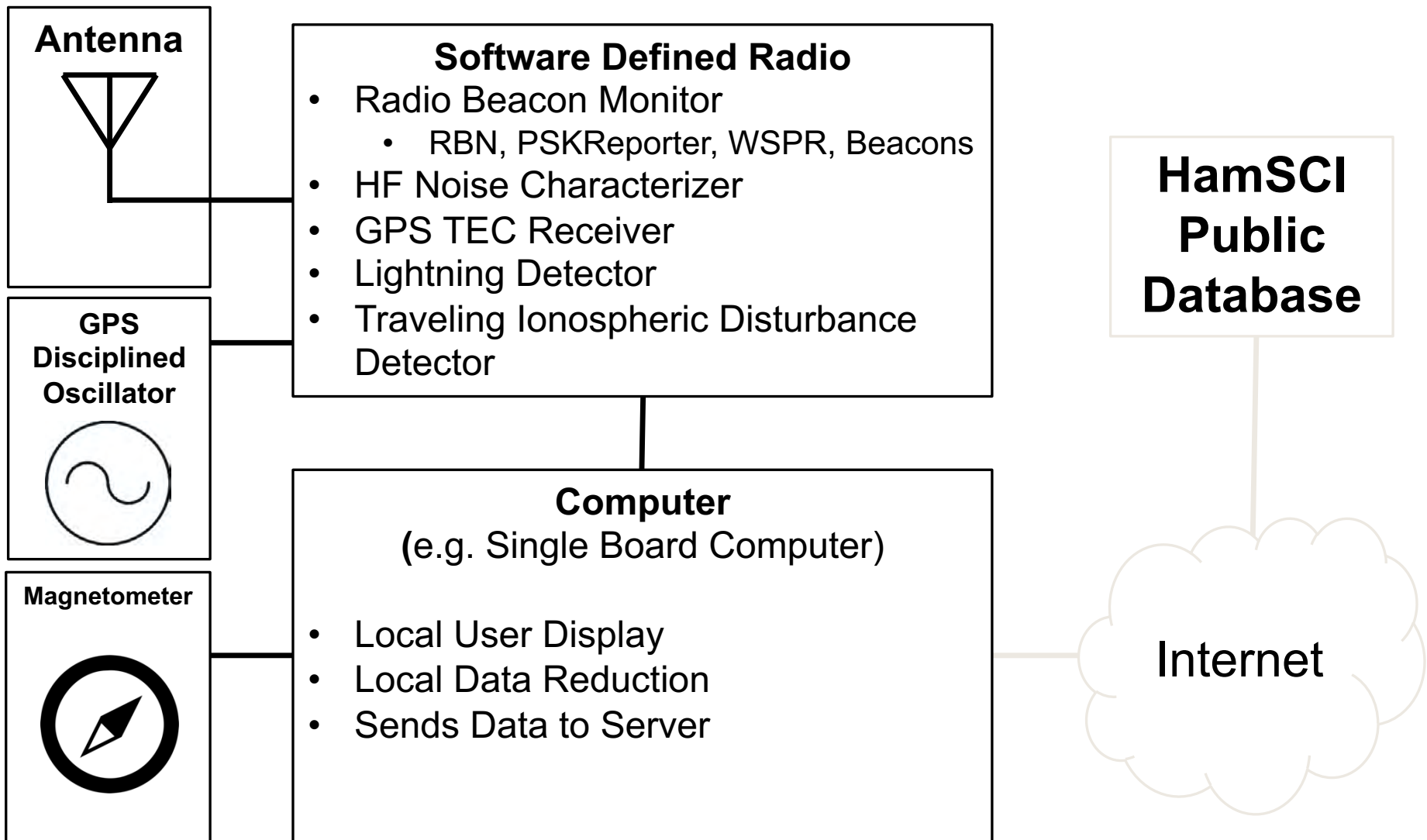


http://www.polarlicht-vorhersage.de/goes_archive

Can we do better?

- This is all great, but ham radio receiver networks weren't designed for science.
- What if we could create a network of Personal Space Weather Stations that were designed for both science (and ham radio!) from the ground up?
- That is the idea behind the HamSCI Personal Space Weather Station project.

Personal Space Weather Station



Personal Terrestrial WX Station

- Multi-instrument
- Internet Connected
- Easy Set-Up
- Reasonable Cost



Ambient Weather WS-2902

Target Specifications

- **Useful to ham radio, space science, and space weather communities.**
- **Modular Instrument Design**
 - Easy ability to add or remove instruments, especially in software architecture
- **Small footprint**
- **Nice User Interface/Local Display**
- **Standard format to send data back to a central repository**
- **Open community-driven design**

PSWS Teams



University of Scranton

- **Nathaniel Frissell W2NAF (PI)**

Responsibilities

- Lead Institution
- HamSCI Lead
- Radio Science Lead



University of Alabama

- **Bill Engelke AB4EJ (Chief Architect)**
- Travis Atkison (PI)

Responsibilities

- Central Database
- Central Control Software
- Local Control Software



MIT Haystack Observatory

- **Phil Erickson W1PJE**

Responsibilities

- Science Collaborator

HamSCI



TAPR & Zephyr Engineering

- **Scotty Cowling WA2DFI (Chief Architect)**
- Tom McDermott N5EG (RF Board)
- John Ackerman N8UR (Clock Module)
- David Witten KD0EAG (Magnetometer)
- David Larsen KV0S (Website)

Responsibilities

- TangerineSDR (High Performance)
- Data Engine
- Ground Magnetometer



Case Western Reserve University Case Amateur Radio Club W8EDU

- **Soumyajit Mandal (PI)**
- **David Kazdan AD8Y (Co-Lead)**
- Kristina Collins KD8OXT
- John Gibbons N8OBJ
- Rob Wiesler AC8YV
- Matt McConnell KC8AWM
- Skylar Dannhoff KD9JPX
- Aidan Montare KB3UMD

Responsibilities

- Low Cost PSWS System



New Jersey Institute of Technology

- **Hyomin Kim KD2MCR (PI)**
- Gareth Perry KD2SAK
- Andy Gerrard KD2MCQ

Responsibilities

- Ground Mag Oversight & Testing
- Science Collaborators

Current Progress

- We are well on our way!
- TAPR has really come to the table in terms of making progress...
 - TangerineSDR Website – <https://tangerinesdr.com/>
 - Specification Documents
 - Listserv
 - Monday Night Telecons
 - Mockup of TangerineSDR



[Scotty WA2DFI explaining the TangerineSDR board mockup](https://youtu.be/81MlpIpB7Mo)

<https://youtu.be/81MlpIpB7Mo>

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.



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

HamSCI Workshop 2020

HamSCI Workshop @ The University of Scranton

Friday, March 20 – Saturday, March 21, 2020

THE UNIVERSITY OF
SCRANTON
A JESUIT UNIVERSITY

HamSCI



- Team Meeting for PSWS
- Special Theme
The Auroral Connection
- Invited Tutorial Speakers
 - Dr. Liz MacDonald (NASA)
 - Dr. Jim LaBelle (Dartmouth)
 - Mr. David Hallidy, K2DH
- Keynote Speaker
 - Mr. Tim Duffy, K3LR
- Lots of Science & Engineering Presentations

<http://hamsci.org/hamsci2020>

HamSCI
<http://hamsci.org>

nathaniel.frissell@scranton.edu

Thank you!
