

# High Frequency Communications Response to Solar Activity in September 2017 as Observed by Amateur Radio Networks

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<sup>5</sup>HamSCI Community

<sup>6</sup>University of California, Los Angeles

# Introduction

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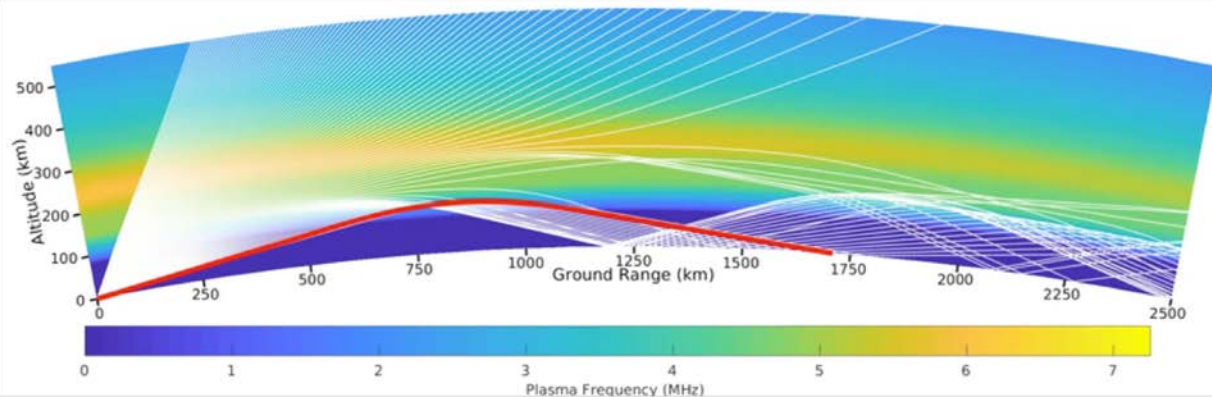
- Numerous solar flares and CME-induced interplanetary shocks occurred September 4-14, 2017, disrupting HF (3-30 MHz) communications.
- Simultaneously, Hurricanes Irma and Jose caused significant damage to the Caribbean Islands and parts of Florida.
- The timing was unfortunate, as HF radio was needed for emergency communications.
- We present of HF amateur radio observations during this period.
  - Reverse Beacon Network (RBN)
  - Weak Signal Propagation Reporting Network (WSPRNet)

# 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



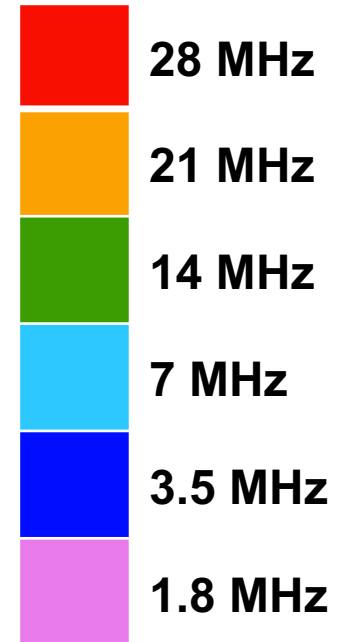
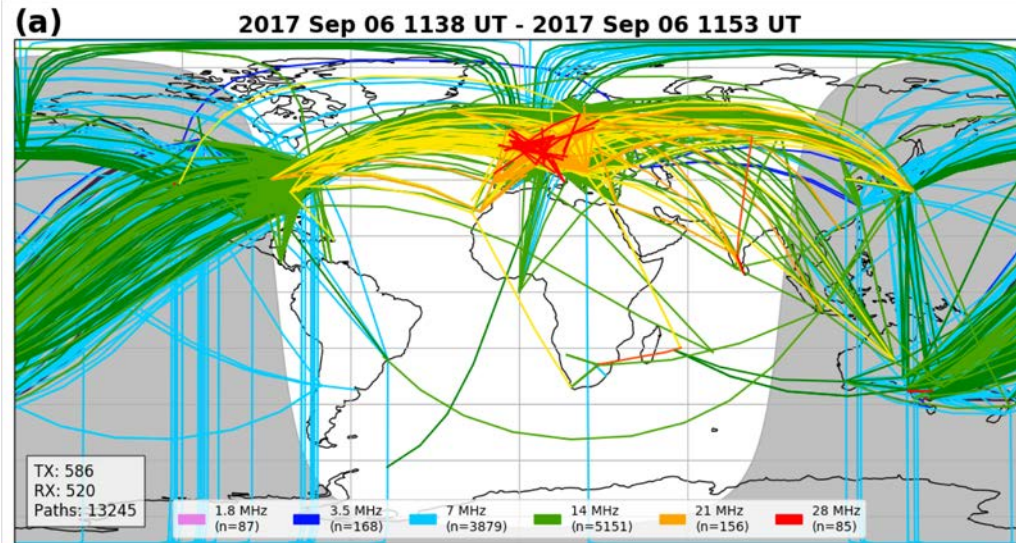
*K2MFF, The NJIT  
Ham Radio  
Station*



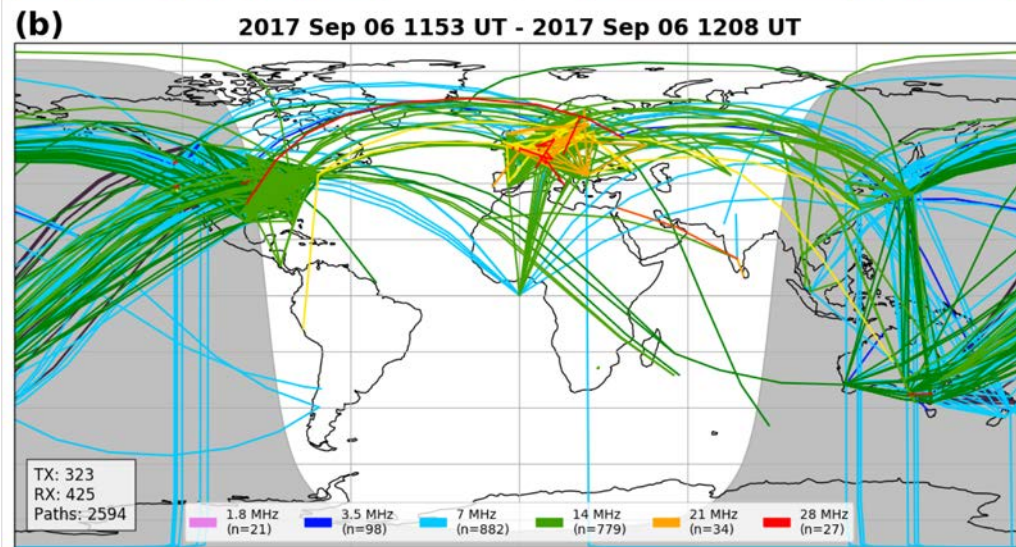
**1600 UT 21 Aug 2017 14.03 MHz - Eclipsed SAMI3  
TX: AA2MF (Florida) RX: WE9V (Wisconsin)**

# HF Response to Solar Flare

13,245 Paths

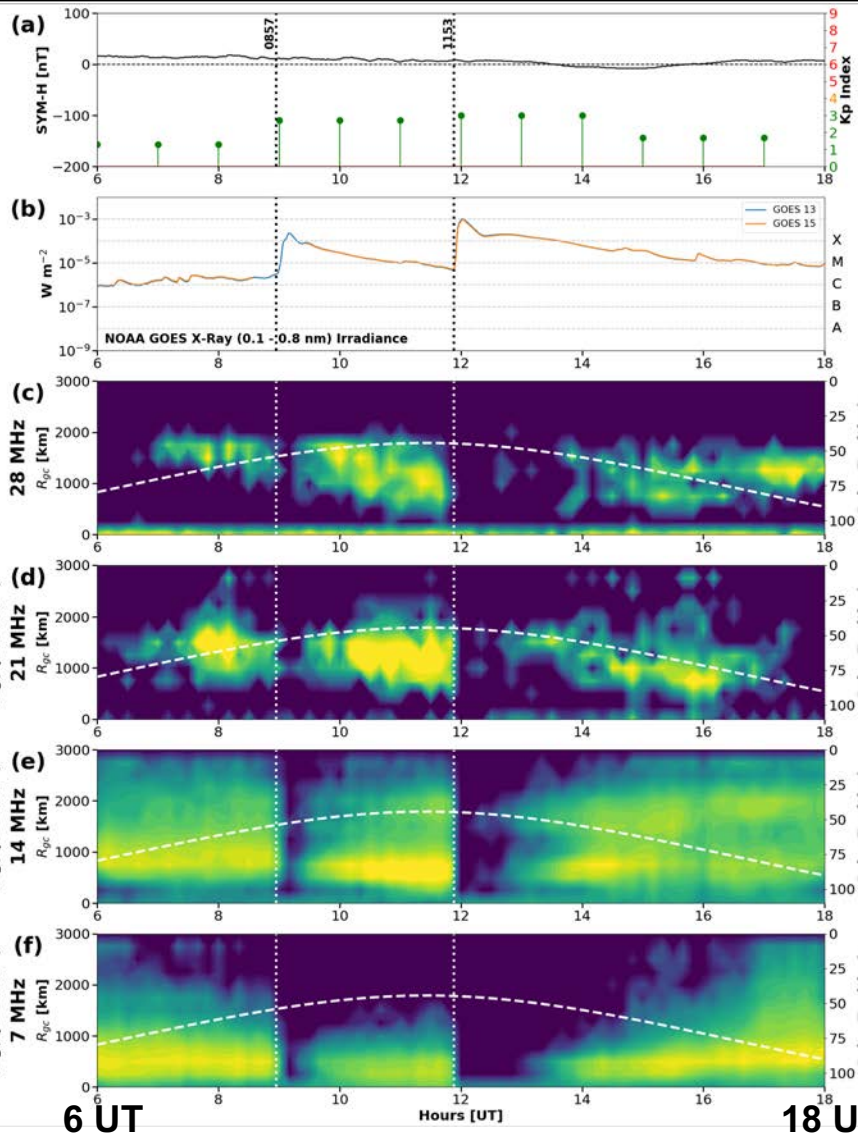


2,594 Paths



# EU Response to Solar Flares

06 Sep 2017  
 Ham Radio Networks  
 N Spots = 185579  
 RBN: 14%  
 WSPRNet: 86%



Quiet Kp/Sym-H

GOES Flares  
 X2.2 & X9.3

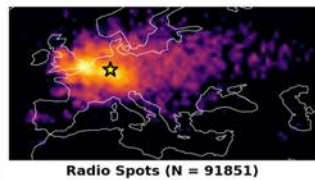
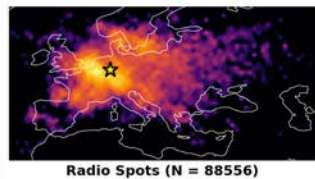
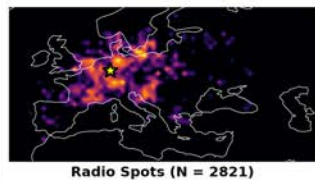
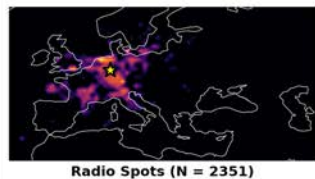
28 MHz

21 MHz

14 MHz

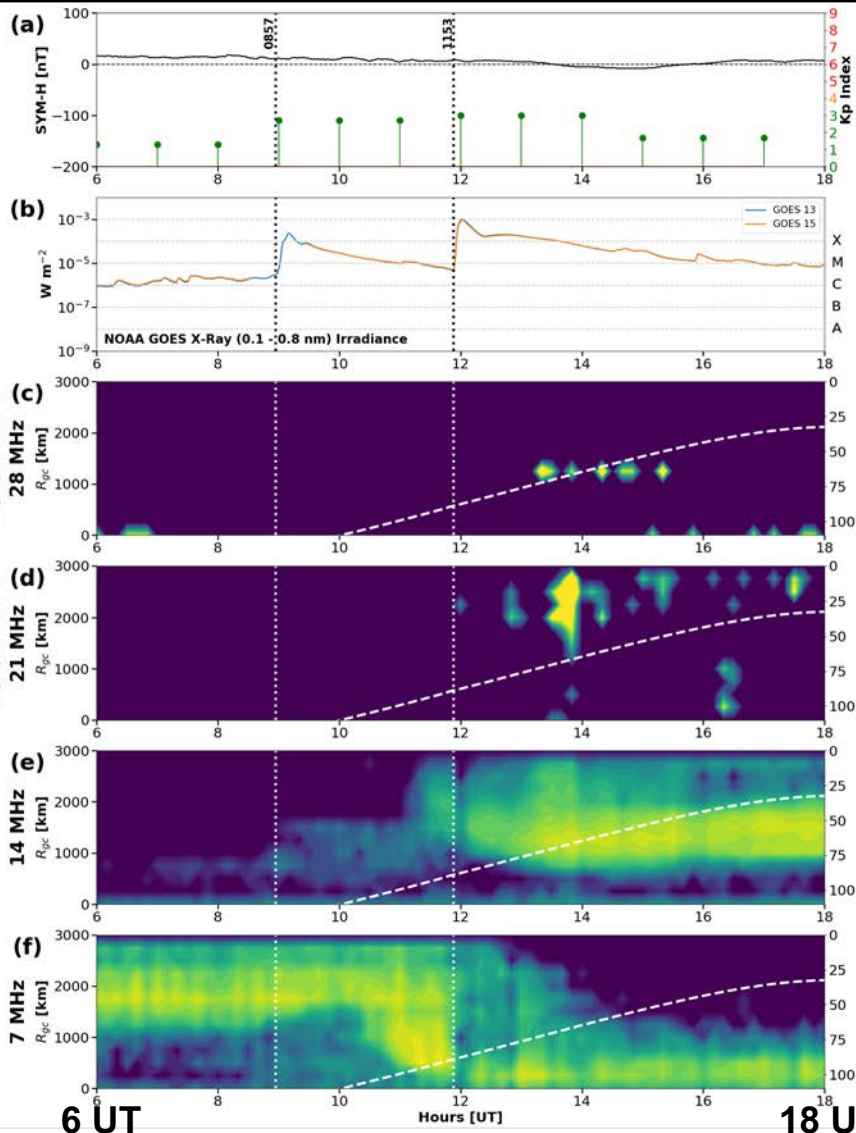
7 MHz

- Europe in daylight.
- Both flares cause deep blackouts.



# US Response to Solar Flares

06 Sep 2017  
 Ham Radio Networks  
 N Spots = 50813  
 RBN: 12%  
 WSPRNet: 88%



Quiet Kp/Sym-H

GOES Flares  
 X2.2 & X9.3

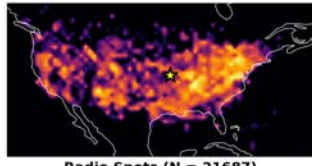
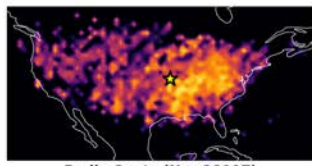
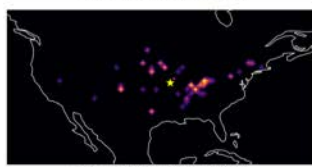
28 MHz

21 MHz

14 MHz

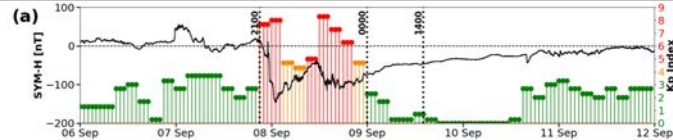
7 MHz

- US is at dawn.
- Diurnal variations evident
- 1<sup>st</sup> Flare has little effect
- 2<sup>nd</sup> flare has small effect

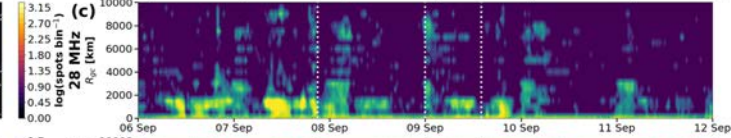
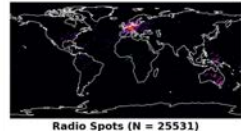
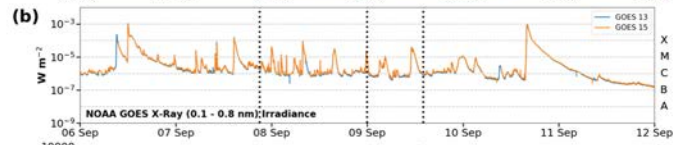


# Global Response to Geomagnetic Storm

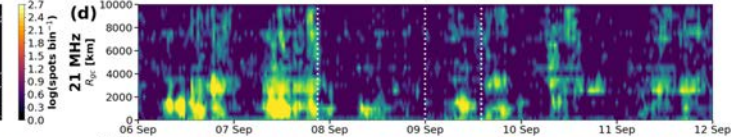
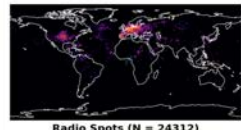
06 Sep 2017-  
12 Sep 2017  
Ham Radio Networks  
N Spots = 3849836  
RBN: 22%  
WSPRNet: 78%



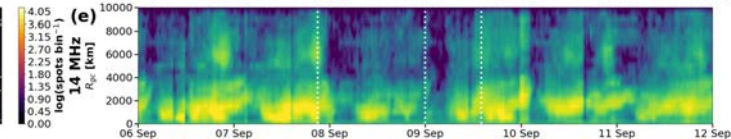
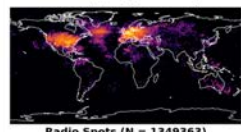
$Kp_{max} = 8+$   
 $SYM-H_{min} = -146 \text{ nT}$



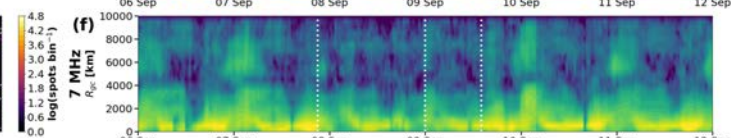
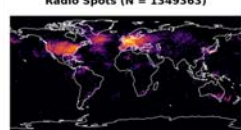
28 MHz



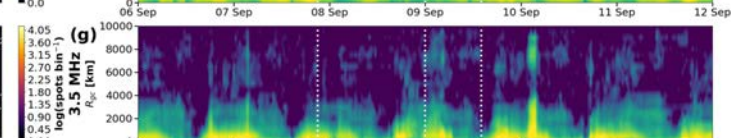
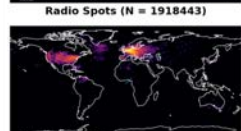
21 MHz



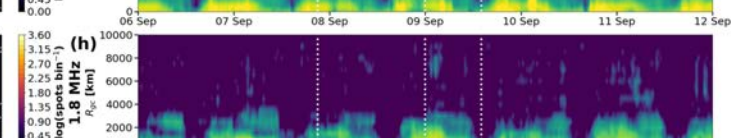
14 MHz



7 MHz



3.5 MHz



1.8 MHz

8 Sept 2100 UT

- Storm Onset

9 Sept 0000 UT

- Geomagnetic Quiet

9 Sept 1400 UT

- Radio Recovery

6 Sept 07 Sep 08 Sep 09 Sep 10 Sep 11 Sep 12 Sept

# Z-Score

$$z = \frac{x - \mu}{\sigma}$$

06 Sep 2017-  
12 Sep 2017  
Ham Radio Networks  
N Spots = 3849836  
RBN: 22%  
WSPRNet: 78%

## Quiet Time Baseline

- 2016-2017
- $-25 < \text{SYM-H} < 25$  nT
- $K_p < 3$
- $n = 283$  days

## 7, 14 MHz

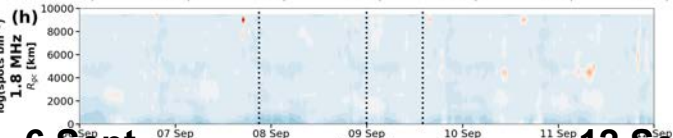
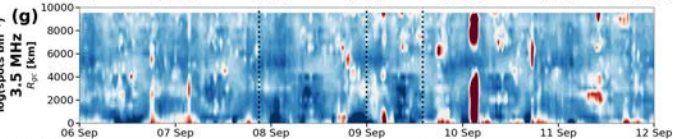
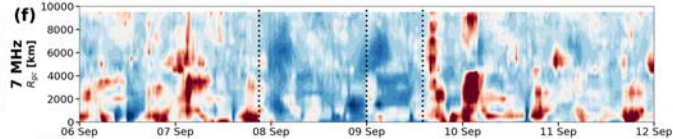
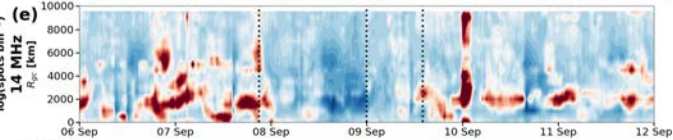
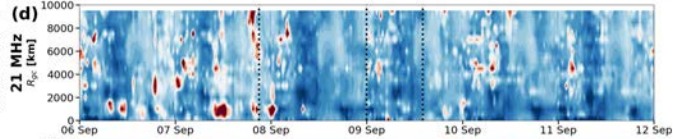
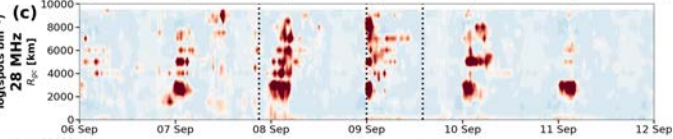
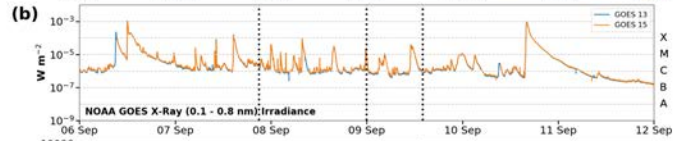
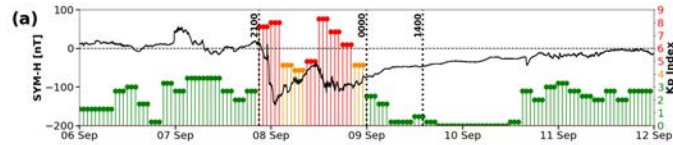
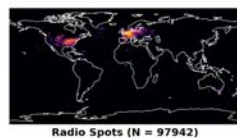
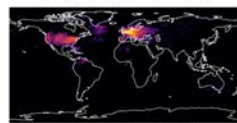
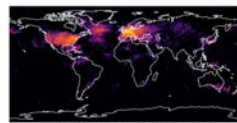
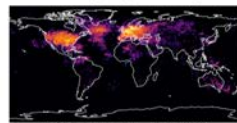
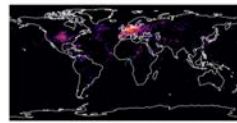
- Clearly below average during storm

## 1.8, 3.5, 21 MHz

- Inconclusive

## 28 MHz

- Above average... more work to be done here...



6 Sept 7 Sept 8 Sept 9 Sept 10 Sept 11 Sept 12 Sept

28 MHz

21 MHz

14 MHz

7 MHz

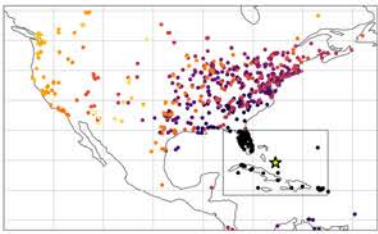
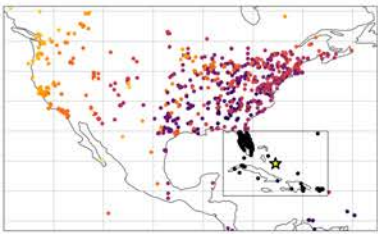
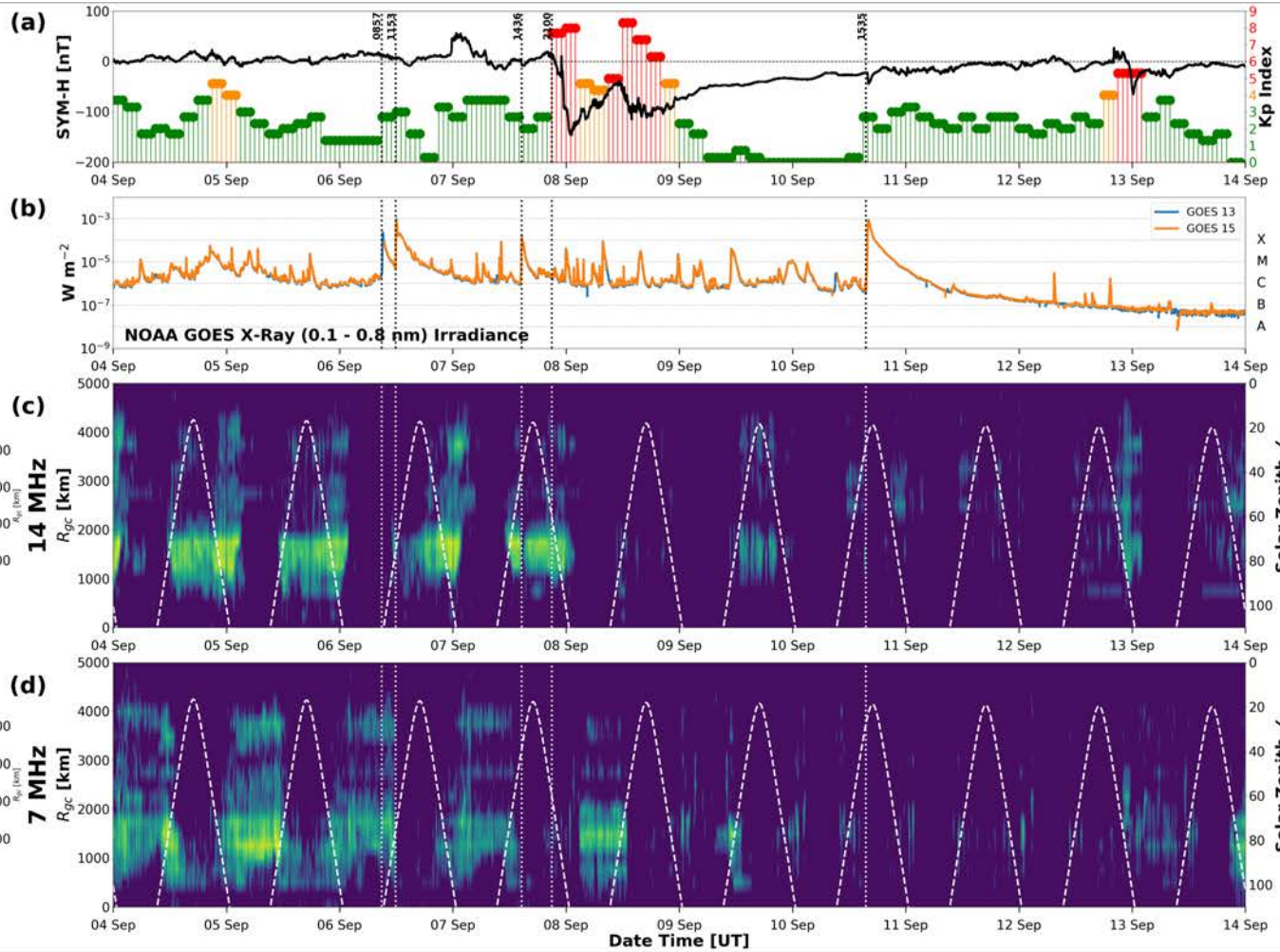
3.5 MHz

1.8 MHz

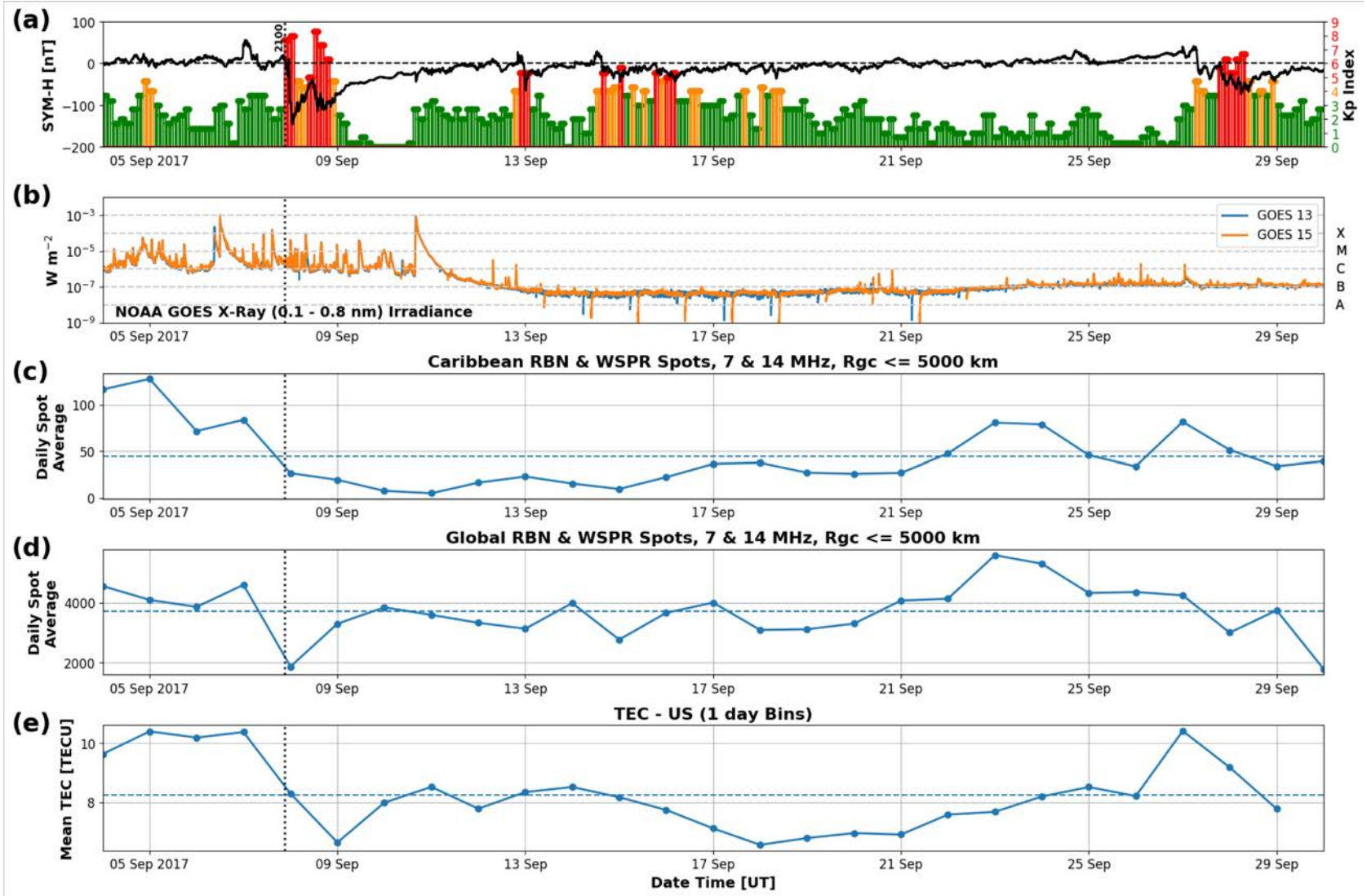


# Caribbean Response

04 Sep 2017-  
14 Sep 2017  
Ham Radio Networks  
N Spots = 71856  
RBN: 18%  
WSPRNet: 82%



# Comparison to Mean US TEC



# Summary and Conclusions

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- X-class flares on 6, 7, and 10 September 2017
  - acute radio blackouts during the day in the Caribbean
  - with recovery times of tens of minutes to hours, based on the decay time of the flare.
- Severe geomagnetic storm 7-10 September 2017
  - $Kp_{\max} = 8+$  and  $SYM-H_{\min} = -146$  nT
  - wiped out ionospheric communications first on 14 MHz and then on 7 MHz starting at ~1200 UT 8 September.
- This storm, combined with effects from additional flare and geomagnetic activity, contributed to a significant suppression of effective HF propagation bands both globally and in the Caribbean for a period of 12 to 15 days.

# Thank you!

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THIS WORK WAS PARTIALLY SUPPORTED BY  
NSF GRANT AGS-1552188/479505-19C75.

# Ham Radio Data Sources

main page - Reverse Beacon Network

reversebeacon.net/main.php

REVERSE BEACON NETWORK

SSN:35 SFI:74 A:4 K:1 callsign lookup: [input]

welcome main dx spots nodes downloads about contact us

Check out RBN's blog at: <http://reversebeacon.blogspot.com>, stay tuned!

Check out your signal compared to others, with the "Spots Analysis Tool". You can compare signals between up to 10 stations heard by a single reverse beacon on a given date.

Donate

options: show/hide

news

RBN blog: stay tuned!

we have 142 skimmers online

skimmers online:

- 3B8CW - 20m
- 7L4IOU - no spot last 15min
- 9M2CNC - 20m
- 9V1RM - 40m, 30m
- AA4VV - 40m, 20m, 17m
- AC0C - no spot last 15min
- BD2FW - no spot last 15min
- BG0ARE - 20m
- BG8NUJ - 30m, 20m
- BH4RRG - no spot last 15min
- DF4UE - 80m, 40m, 30m, 20m, 17m
- DF4XX - 80m, 40m, 20m
- DJ3AK - no spot last 15min
- DJ9IE - 40m, 30m, 20m, 17m
- DK0TE - 40m, 20m
- DK3UA - 40m, 30m
- DK8NE - 6m
- DK9IP - 40m, 30m, 20m
- DL3KR - 40m, 20m
- DL4RCK - 20m
- DL6ZB - 10m
- DL8LAS - 80m, 40m, 30m, 20m
- DL9GTB - 80m, 40m, 30m, 20m, 17m
- DO4DXA - 80m, 40m, 20m, 15m
- EASWU - 40m, 30m, 20m, 17m, 15m, 12m
- E6AVQ - no spot last 15min

Map Satellite

150m / 80m / 40m / 30m / 20m / 17m / 15m / 10m / 10m / 6m / 3m

world wide / zoom to US / zoom to Europe / zoom to North Atlantic

show/hide my last filters

no filter selected, showing all spots

search spot by callsign

rows to show: 15

de	dx	freq	cq/dx	snr	speed	time
EASWU	DJ1YFK	21025.2	CW CQ [LoTW]	11 dB	27 wpm	1549z 22 Jun
K9IMM	W0ERE/B	10129.1	CW BCN	2 dB	19 wpm	1549z 22 Jun

RBN  
reversebeacon.net

Map | WSPRnet

Not Secure wsprnet.org/drupal/wsprnet/map

WSPRnet

Welcome to the Weak Signal Propagation Reporter Network

Activity | Map | Database | Stats | Forum | Downloads

User login

Username \*

Password \*

Create new account

Request new password

Login

Frequencies

USB dial (MHz): 0.130, 0.4742, 1.8396, 3.5920, 5.2872, 7.0366, 10.1387, 14.0956, 18.1046, 21.0946, 24.9246, 28.1246, 50.293, 70.091, 144.489, 432.300, 1296.500

Spot Count

695,665,353 total spots

928,573 in the last 24 hours

35,721 in the last hour

Navigation

Forums

Who's online

There are currently 113 users online.

- WEAX
- G7JT

Map Satellite

150m / 80m / 40m / 30m / 20m / 17m / 15m / 10m / 10m / 6m / 3m

world wide / zoom to US / zoom to Europe / zoom to North Atlantic

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de	dx	freq	cq/dx	snr	speed	time
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K9IMM	W0ERE/B	10129.1	CW BCN	2 dB	19 wpm	1549z 22 Jun

WSPRNet  
wsprnet.org

# HamSCI

The Ham radio Science Citizen Investigation 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.



*Founder/Lead HamSCI Organizer:*

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

*NJIT Center for Solar-Terrestrial Research*



HamSCI  
<http://hamsci.org>

NJIT

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