New Jersey Institute of Technology

HamSCI

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

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Introduction

- 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)

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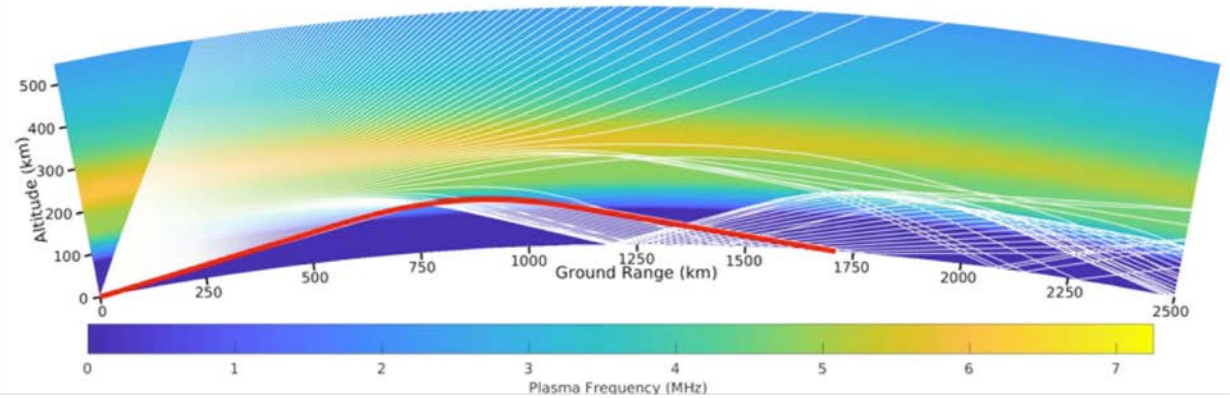
Amateur Radio and the HF Bands

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.



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

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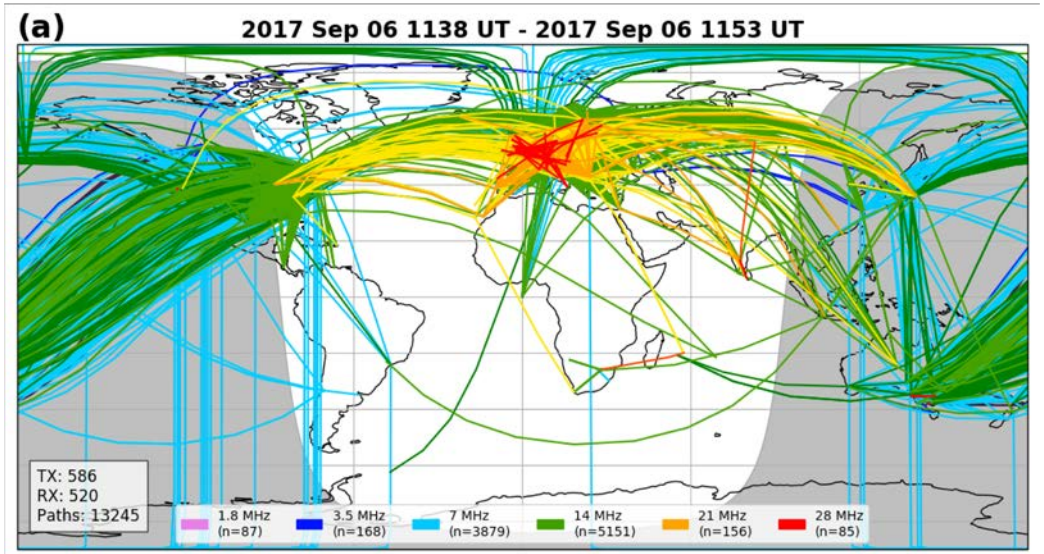
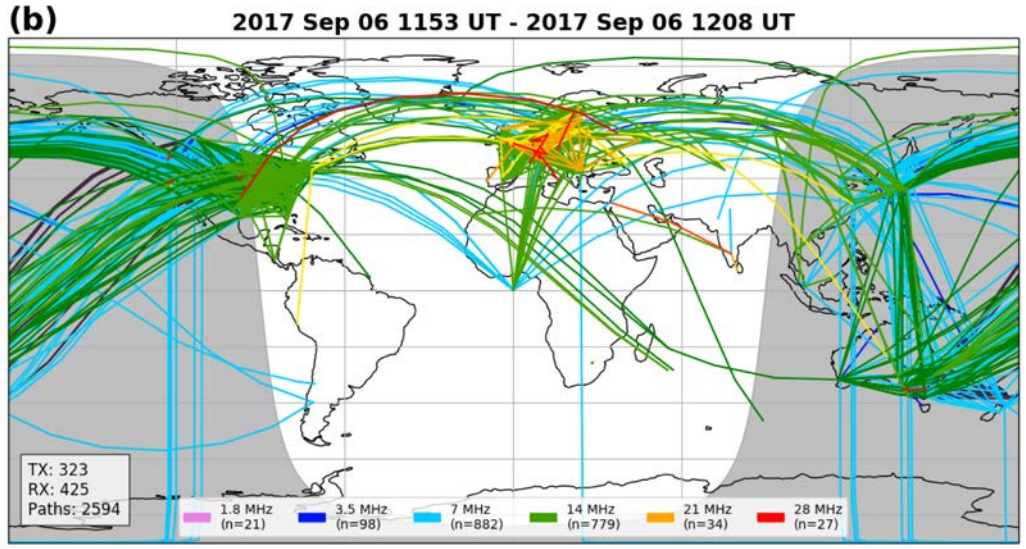
HF Response to Solar Flare

13,245 Paths

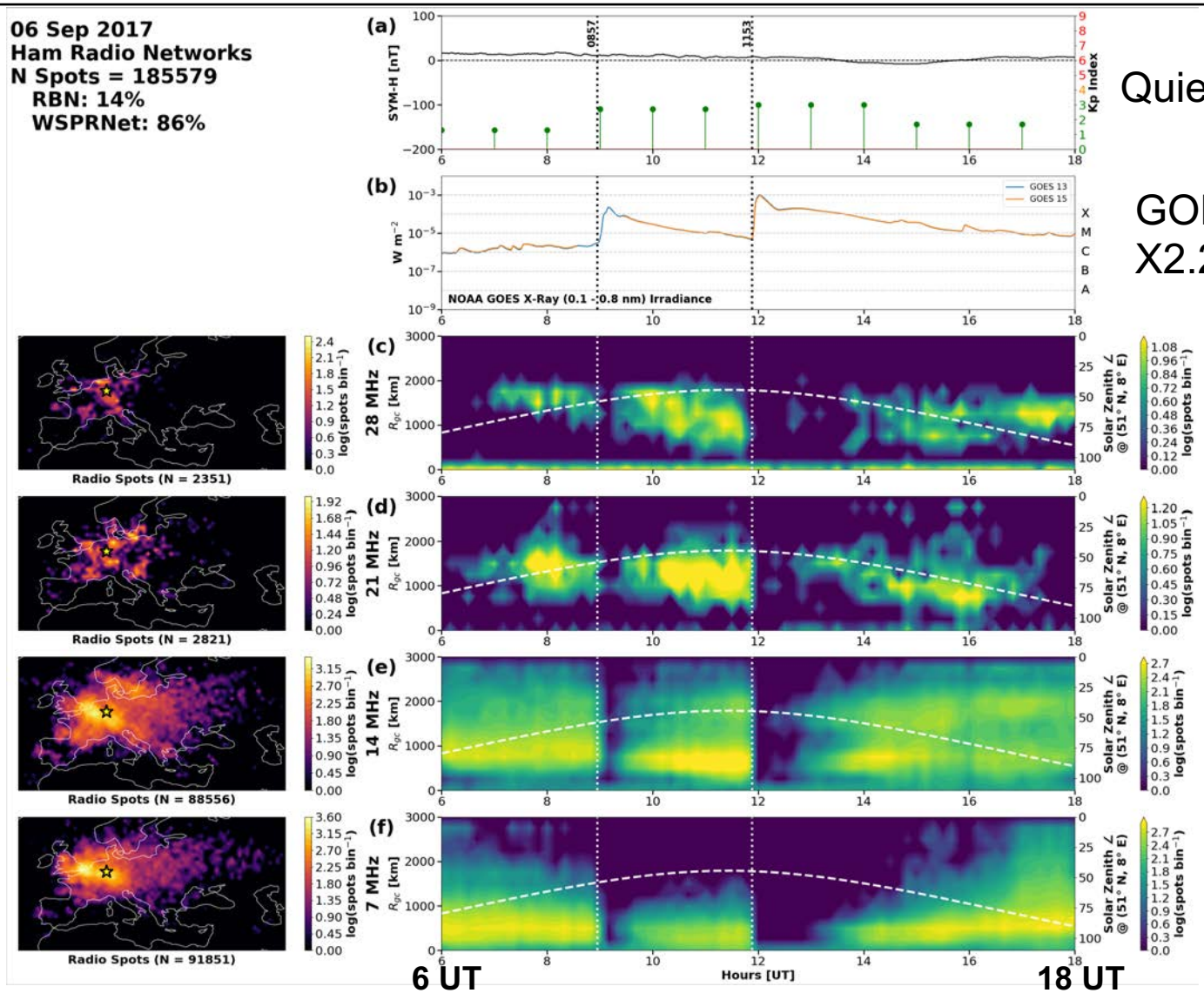


2,594 Paths



EU Response to Solar Flares

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



Quiet Kp/Sym-H

GOES Flares X2.2 & X9.3

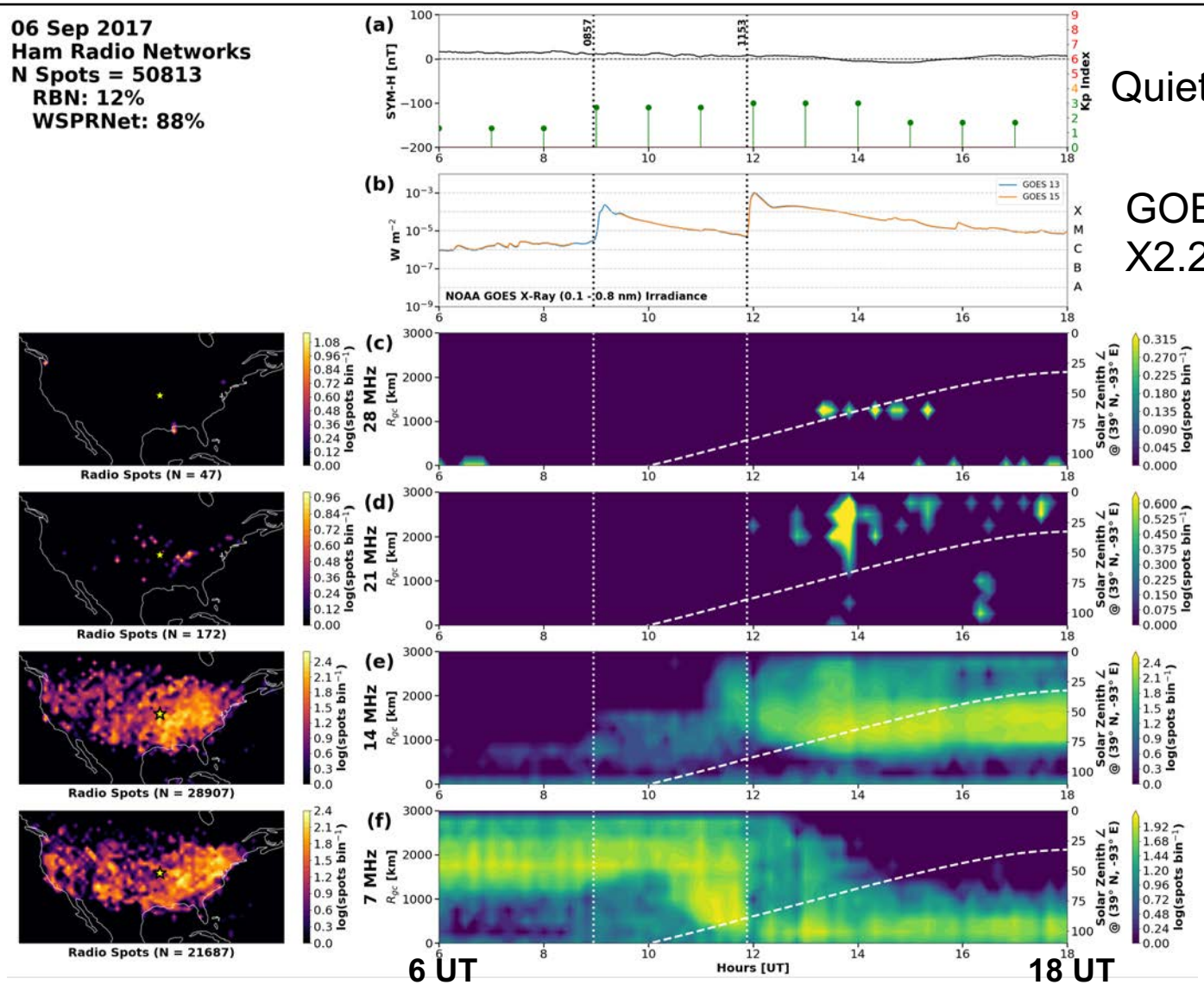
28 MHz

21 MHz

14 MHz

7 MHz

US Response to Solar Flares



Quiet Kp/Sym-H

GOES Flares
X2.2 & X9.3

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

28 MHz

21 MHz

14 MHz

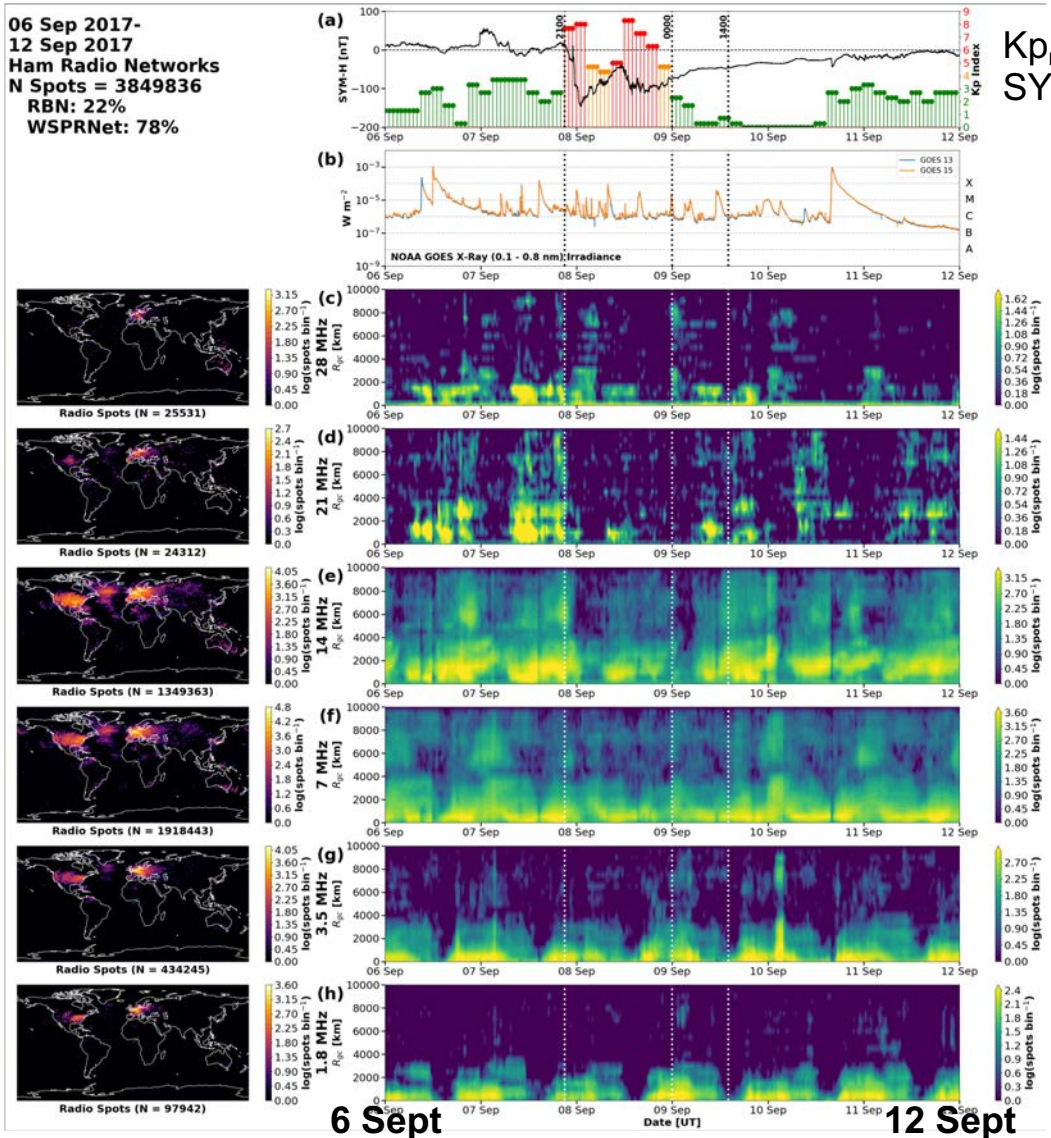
7 MHz

Global Response to Geomagnetic Storm

8 Sept 2100 UT
- Storm Onset

9 Sept 0000 UT
- Geomagnetic Quiet

9 Sept 1400 UT
- Radio Recovery



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

28 MHz

21 MHz

14 MHz

7 MHz

3.5 MHz

1.8 MHz

6 Sept **12 Sept**

Z-Score

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

Quiet Time Baseline

- 2016-2017
- -25 < SYM-H < 25 nT
- K_p < 3
- n = 283 days

7, 14 MHz

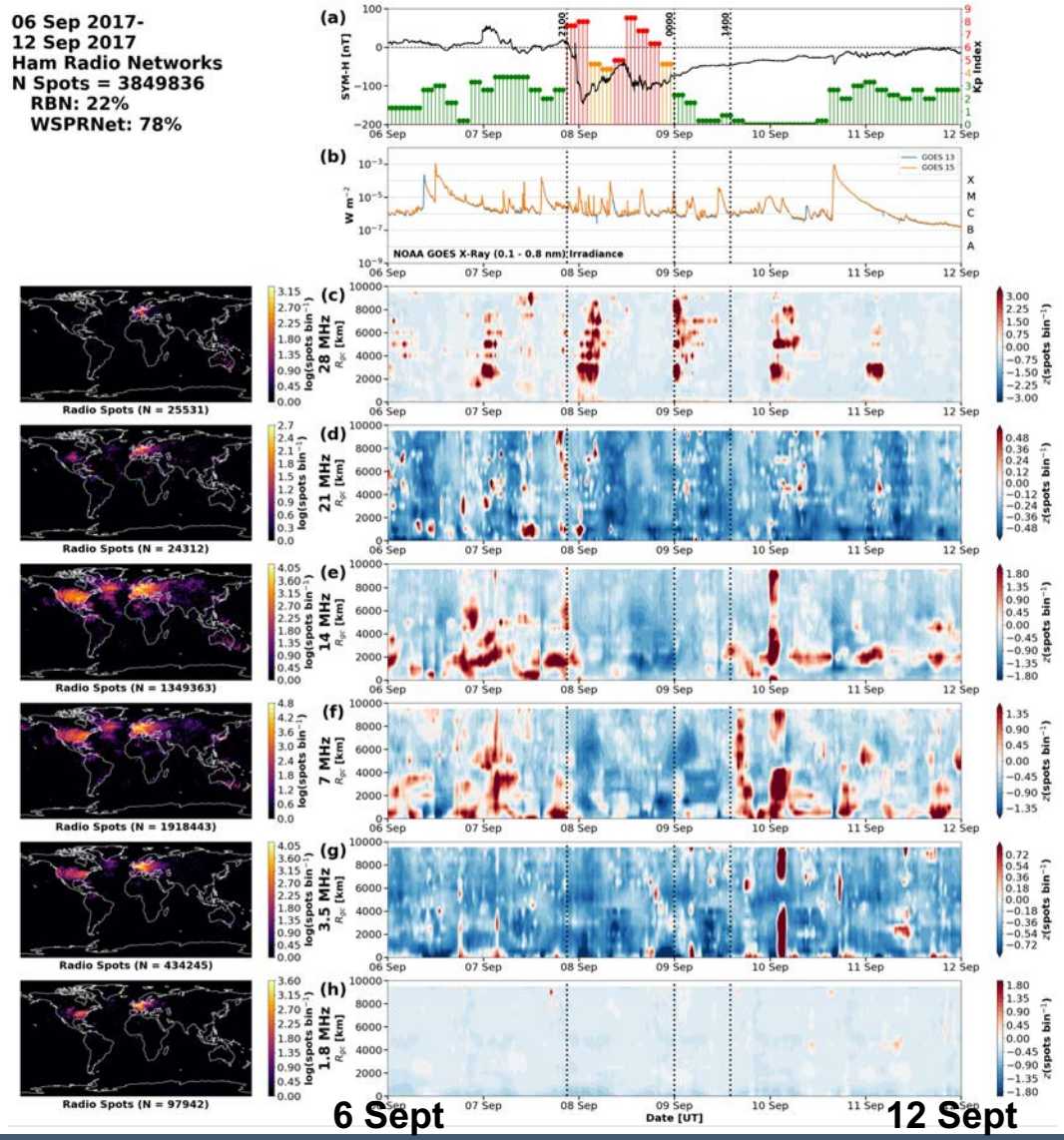
- Clearly below average during storm

1.8, 3.5, 21 MHz

- Inconclusive

28 MHz

- Above average… more work to be done here…



6 Sept 12 Sept

28 MHz

21 MHz

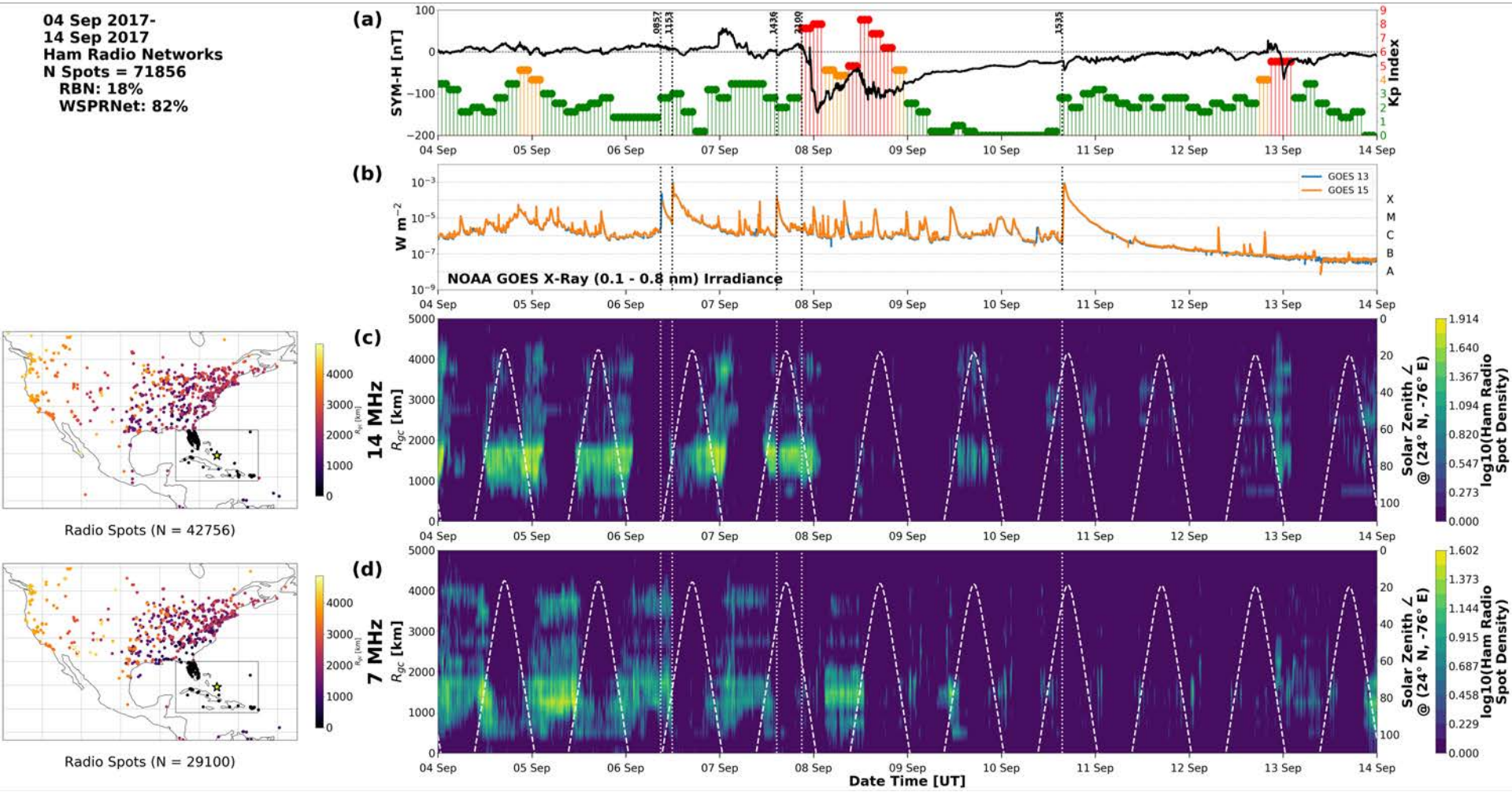
14 MHz

7 MHz

3.5 MHz

1.8 MHz

Caribbean Response



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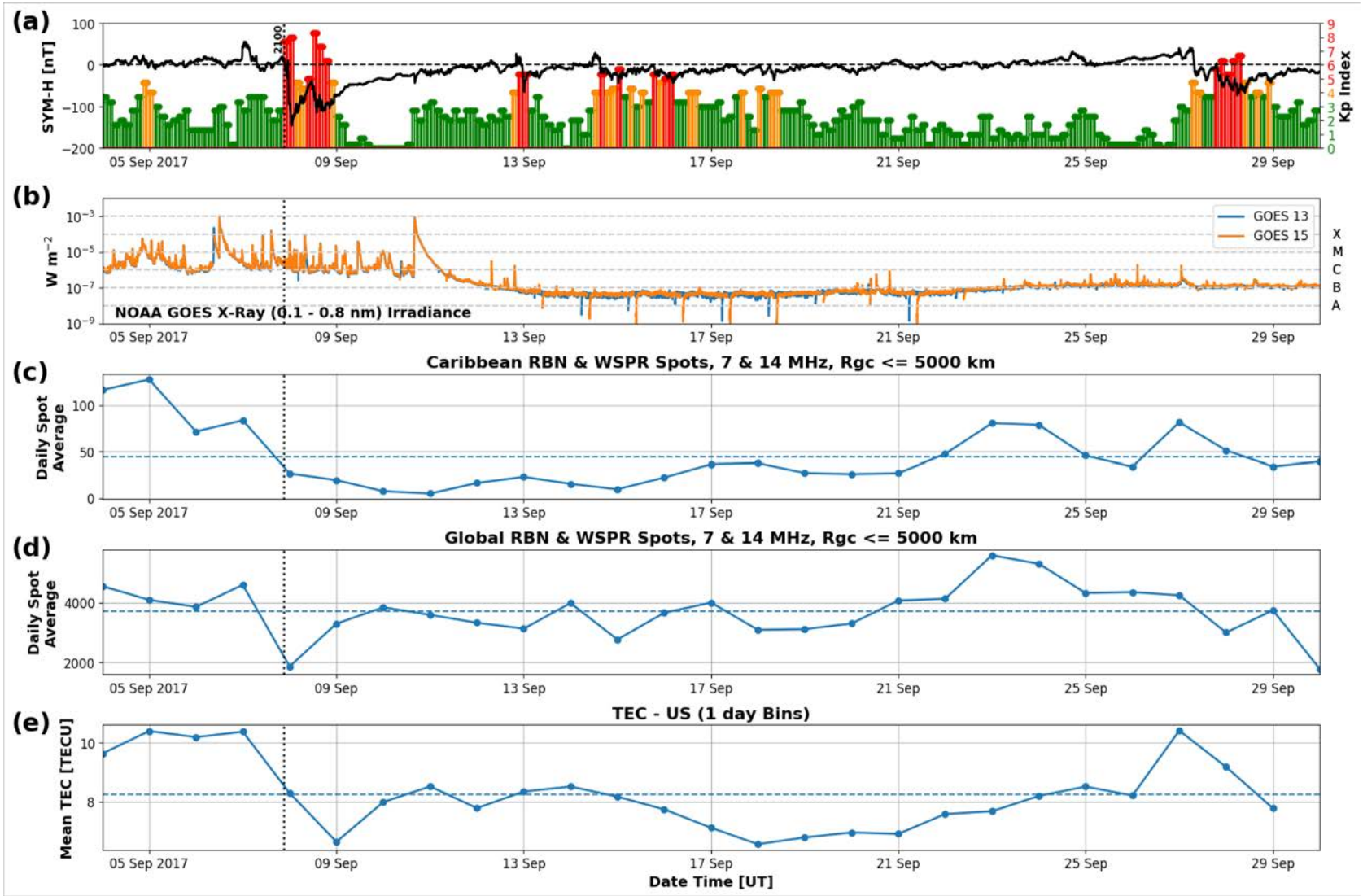
Comparison to Mean US TEC



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Summary and Conclusions

- 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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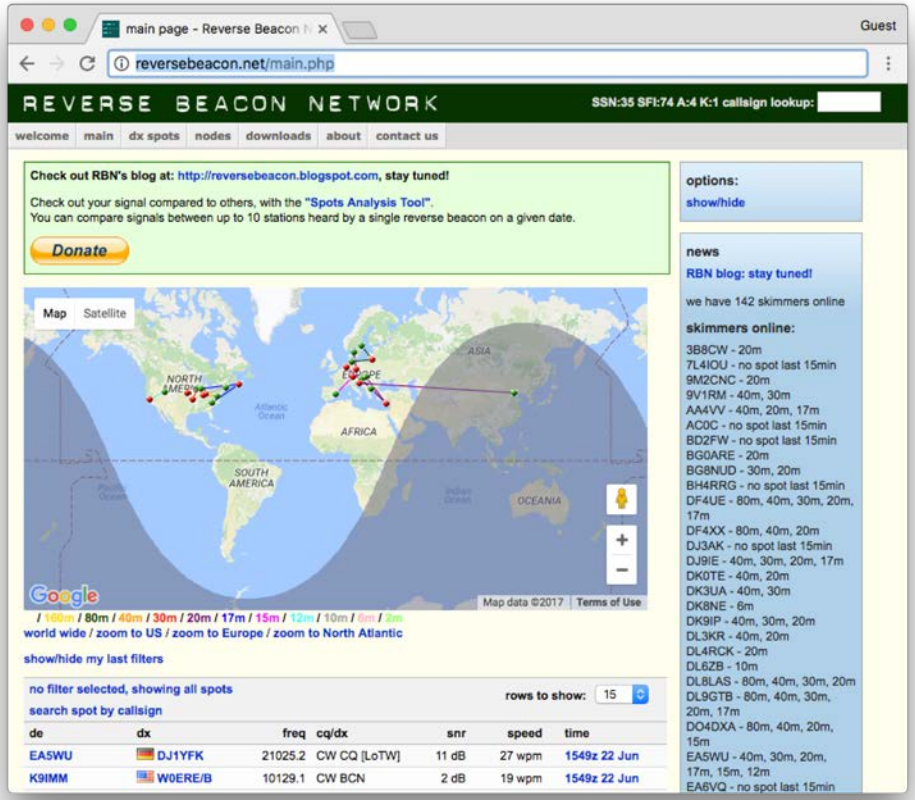
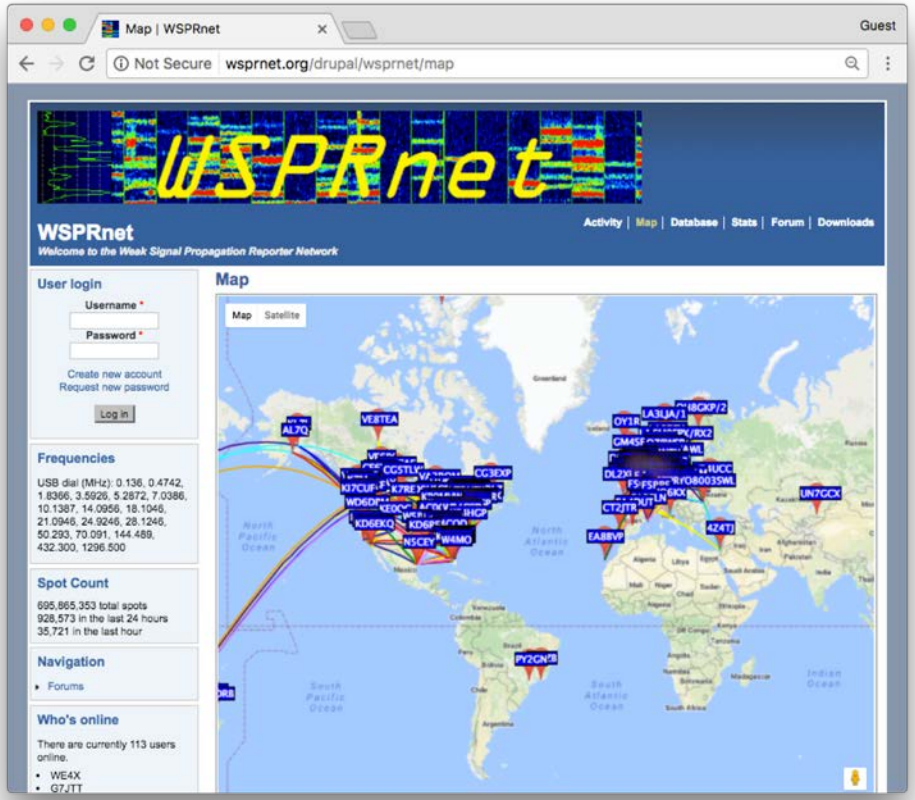
Ham Radio Data Sources



RBN

reversebeacon.net



WSPRNet

wsprnet.org

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:
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NJIT Center for Solar-Terrestrial Research