HF Ham Radio

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Questions!

How far can radio waves travel?



Questions!

What path do radio waves travel to get from one place to another?



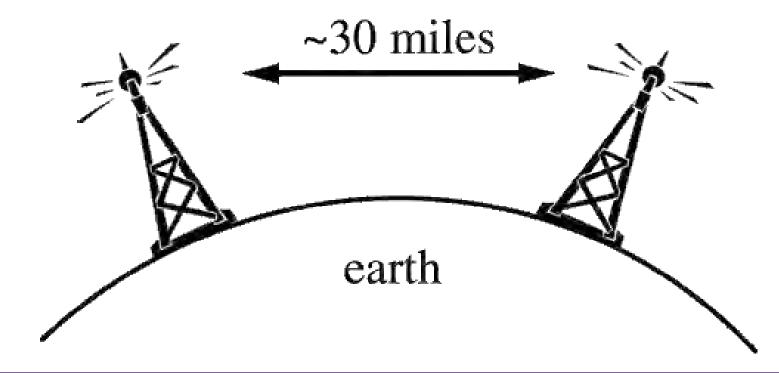
Basic Modes of Propagation

- 1. Line-of-Sight (VHF+, > 30 MHz)
- 2. Ground Wave (MF and Below, < 3 MHz)
- 3. Sky-wave/Skip (HF, 3-30 MHz)



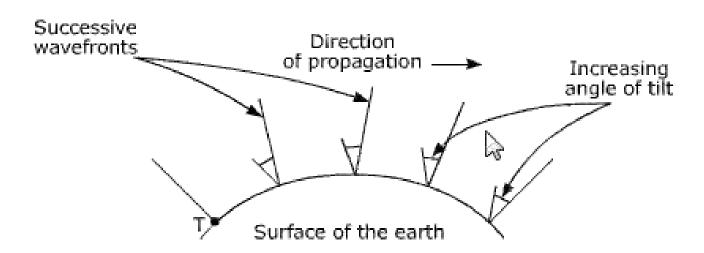
1. Line-of-Sight Propagation

- Signals travel in straight line
- Propagation Limited by Curve of the Earth
- Very High Frequency (VHF) and above (> 30 MHz)



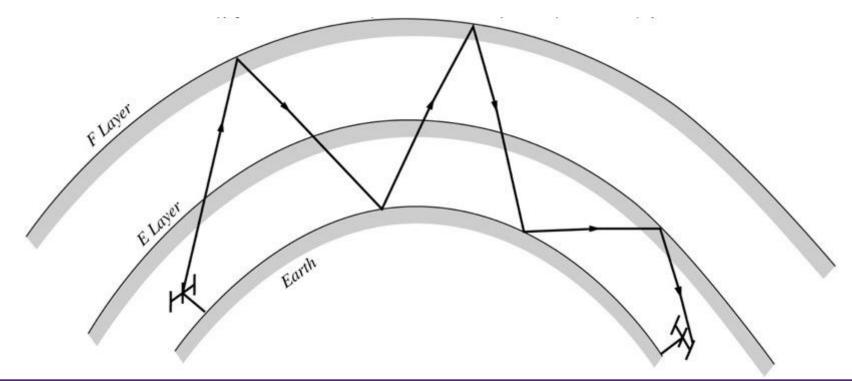
2. Ground Wave Propagation

- Signals follow path of the ground
- •Farther than line-of-sight, shorter than skywave
- MF (Medium Frequency) and below (< 3 MHz)
- •Occurs because currents are induced in the surface of the earth and this action slows down the wave-front in this region, causing the wave-front of the radio communications signal to tilt downwards towards the Earth.



3. Skywave Propagation

- Signals refract off the ionosphere
- •Travel Long Distances
- •HF (High Frequency, 3-30 MHz)
- •Highly dependent on Space Weather!



What is shortwave / HF radio?

•Radio signals between 3 – 30 MHz that can travel around the world.



https://en.wikipedia.org/wiki/Wireless_telegraphy#/media/File:SCR188.jpg



This 10kW transmitter, installed in 1937 by CBS at its shortwave station W2XE in Wayne, N.J., was used to broadcast to South America. (Source: radioworld.com)

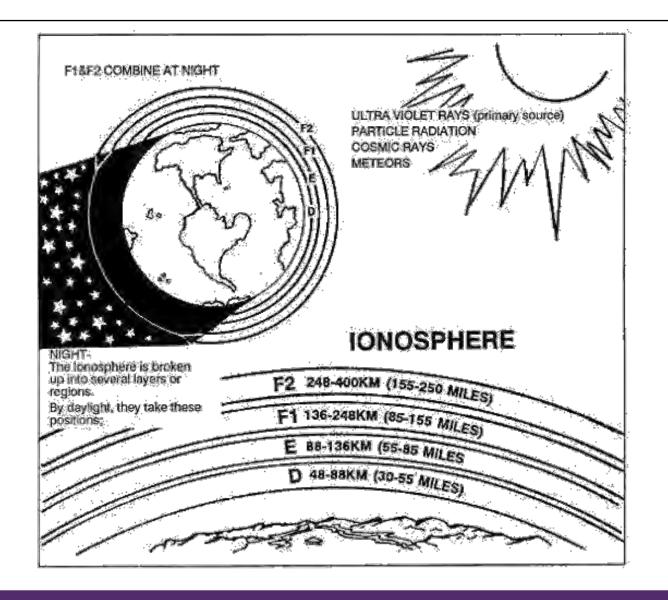


Shortwave is still used today!

- Emergency Communications
- Military
- Commercial Airliners
- Ships on the High Seas
- Amateur (Ham) Radio Operators
- Researchers

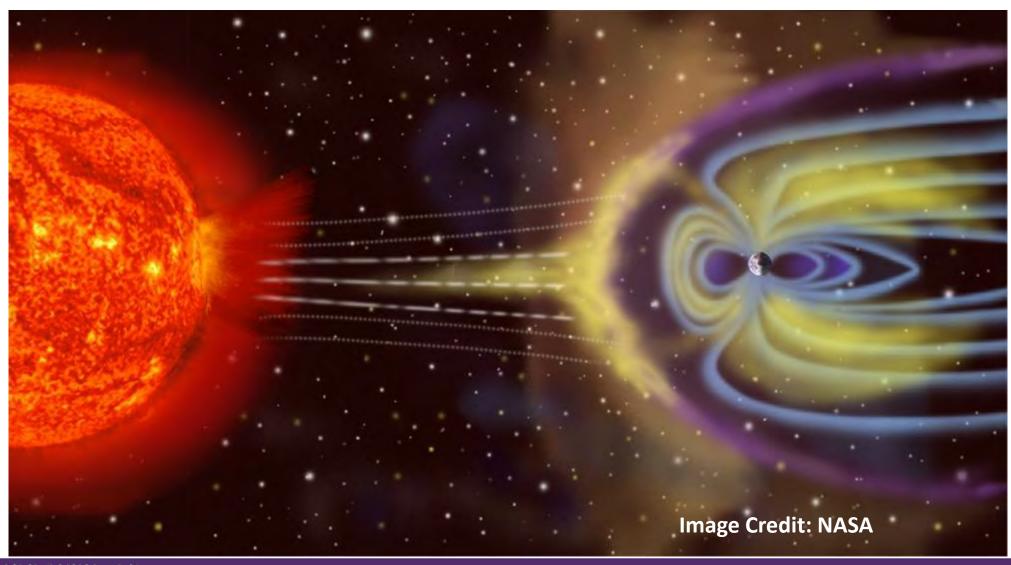


Ionosphere



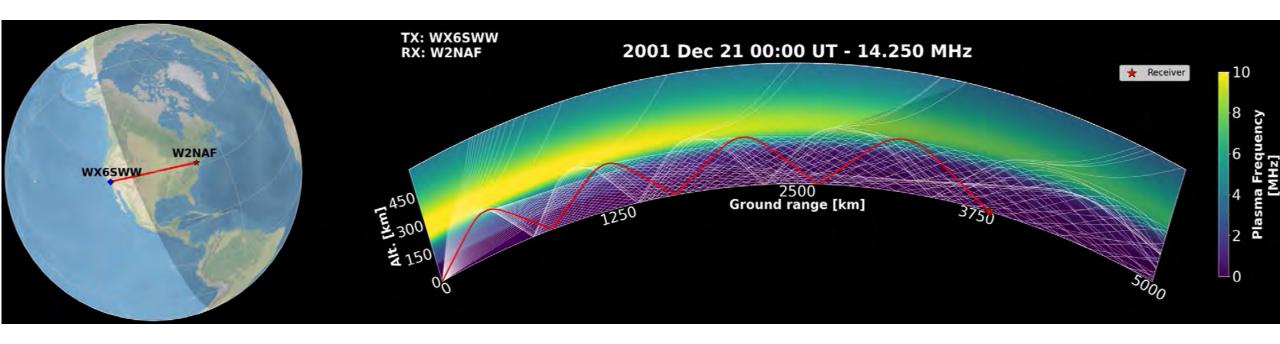


Space Weather





Skip Propagation





What is Amateur (Ham) Radio?

Hobby for Radio Enthusiasts

- Communicators
- Builders
- Experimenters

Wide-reaching Demographic

- All ages & walks of life
- Over 760,000 US amateurs; ~3 million
 Worldwide

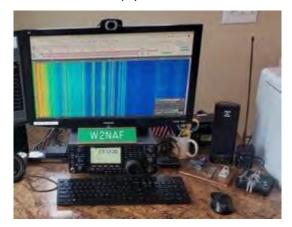
Licensed by the Federal Government

- Basic RF electrical engineering knowledge
- Each amateur radio station has a government-issued "call sign"



University of Scranton Students at W3USR

Photo by Byron Maldonado



W2NAF Home Station



Earning Your License

Three Levels of Ham Radio License:

- 1. Technician
- 2. General
- 3. Amateur Extra

- •Each license gives you progressively more frequency transmission privileges.
- •Each is a multiple choice exam from a public question pool.
- •Visit https://hamstudy.org/ for both practice and real exams!



Call Signs

•Ham radio call signs generally have the following format:

W3<mark>USR</mark>

Prefix: Tells you the country and sometimes geography within the country

Ham radio "countries" are actually DX Century Club or DXCC entities. You can see the current list here:

http://www.arrl.org/files/file/DX CC/2020%20Current Deleted.txt

Suffix: Does not normally give any special information.

The easiest way to figure out the DXCC entity of a call sign is to search it on qrz.com.



Call Sign Map



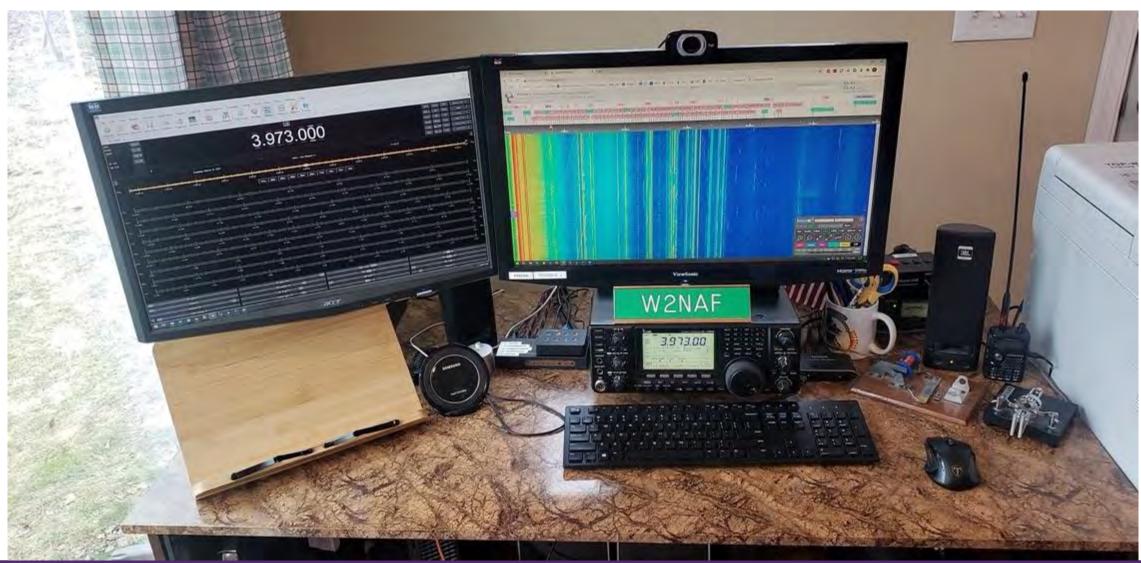


Some Country Call Sign Prefixes

Prefix	Country
K, W, N, AA-AK	United States
EI, EJ	Ireland
GM, GS, MM	Scotland
GW, GC, MW	Wales
G, GX, M	England
LA, LN	Norway
L, LU, LW	Argentina
LY	Lithuania
KL7	Alaska
UR-UZ, EM, EO	Ukraine



W2NAF Ham Radio Station





My House





My Antenna





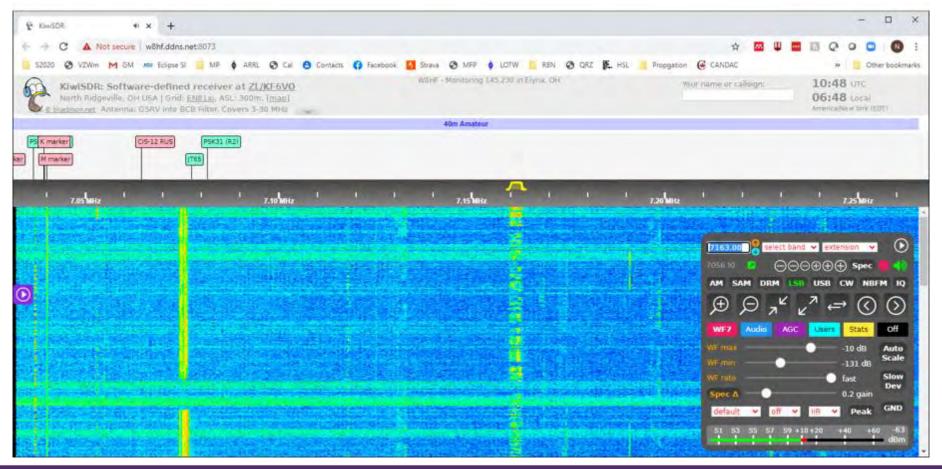
My KiwiSDR





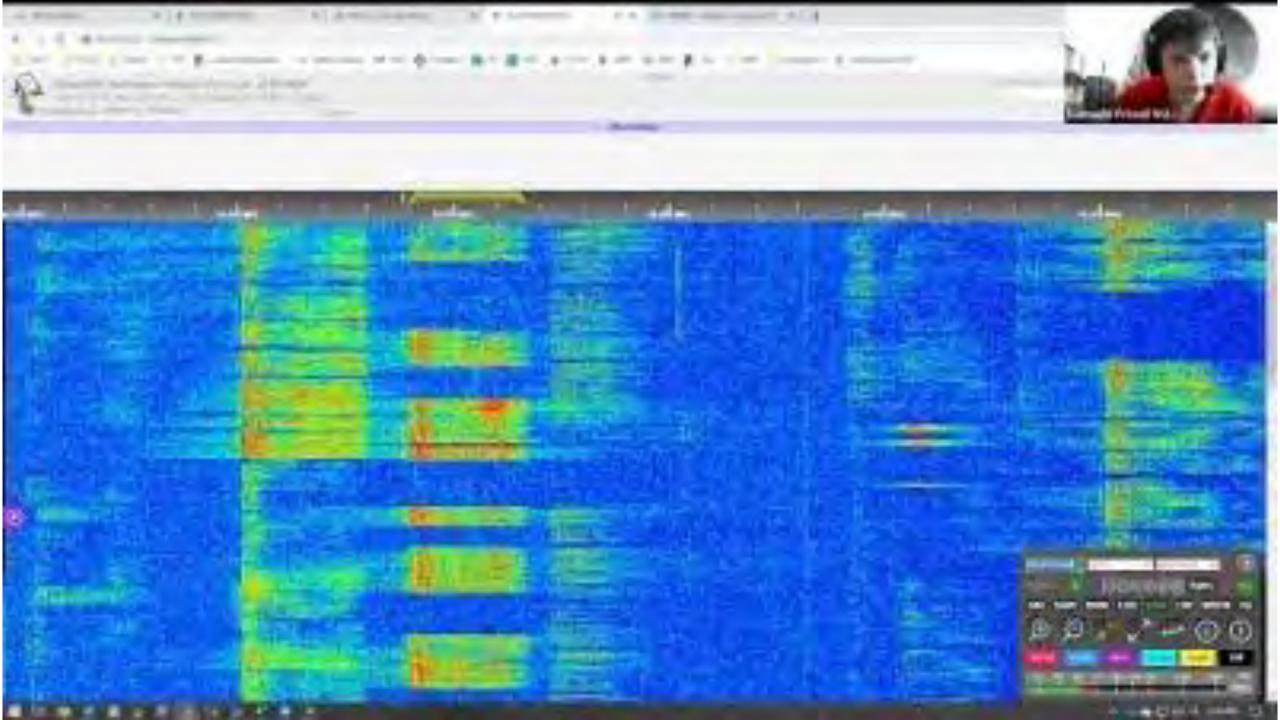
KiwiSDRs

•If you don't have your own radio at home, you can use a remote receiver over the internet. Visit http://kiwisdr.com/ and look for "listen live".



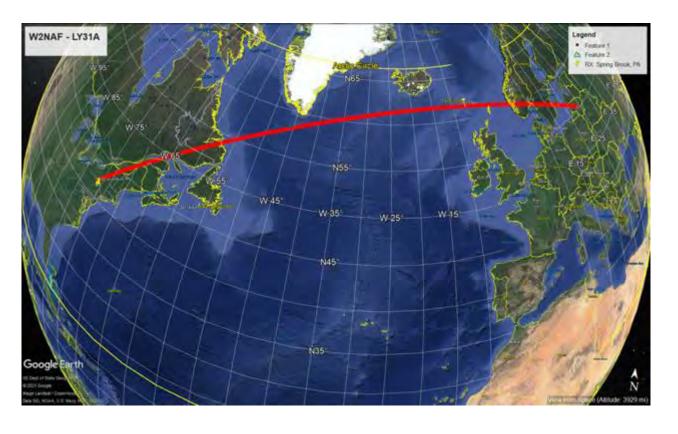


Listening to Ham Radio on KiwiSDR



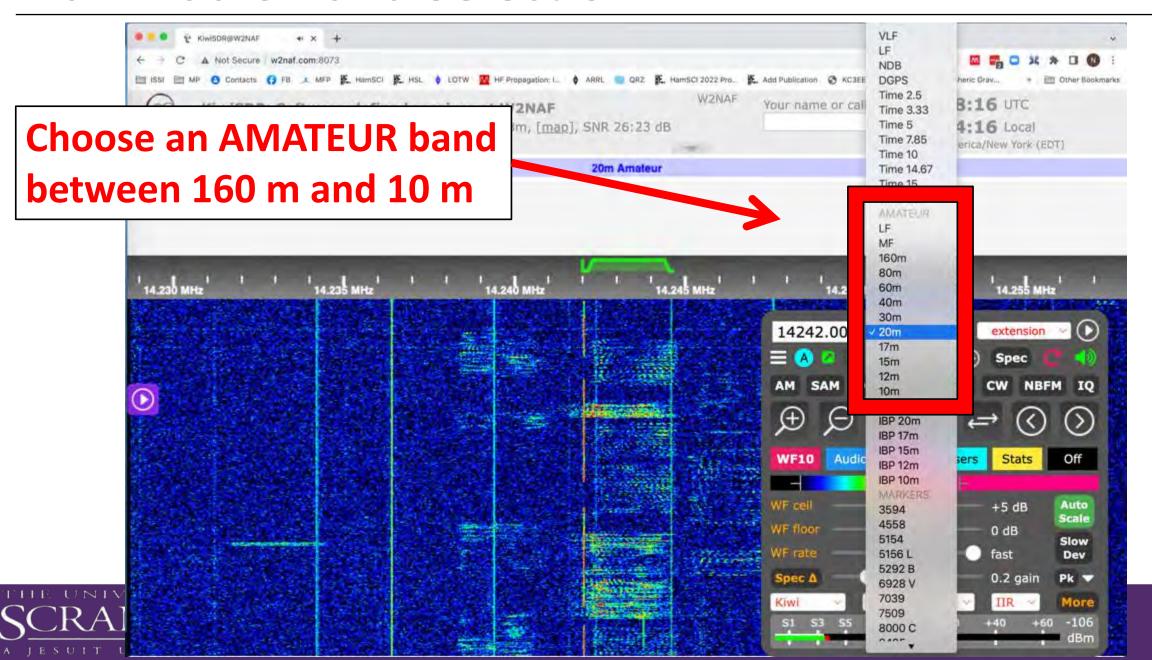
LY31A (Lithuania)



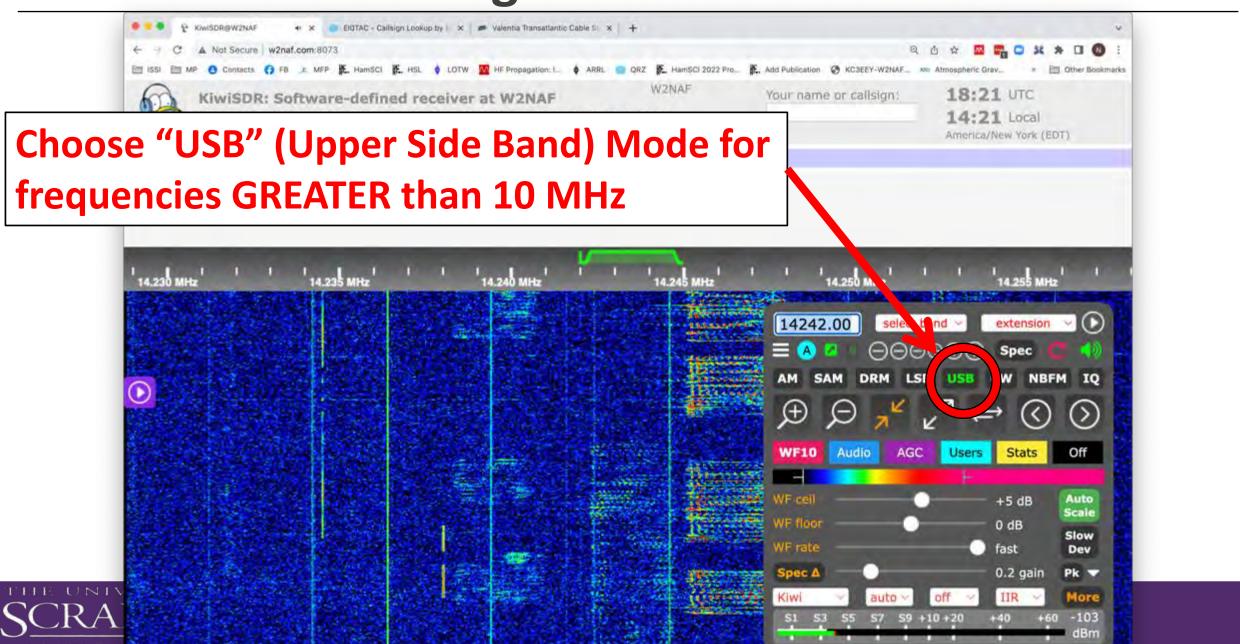


4200 miles (6800 km)

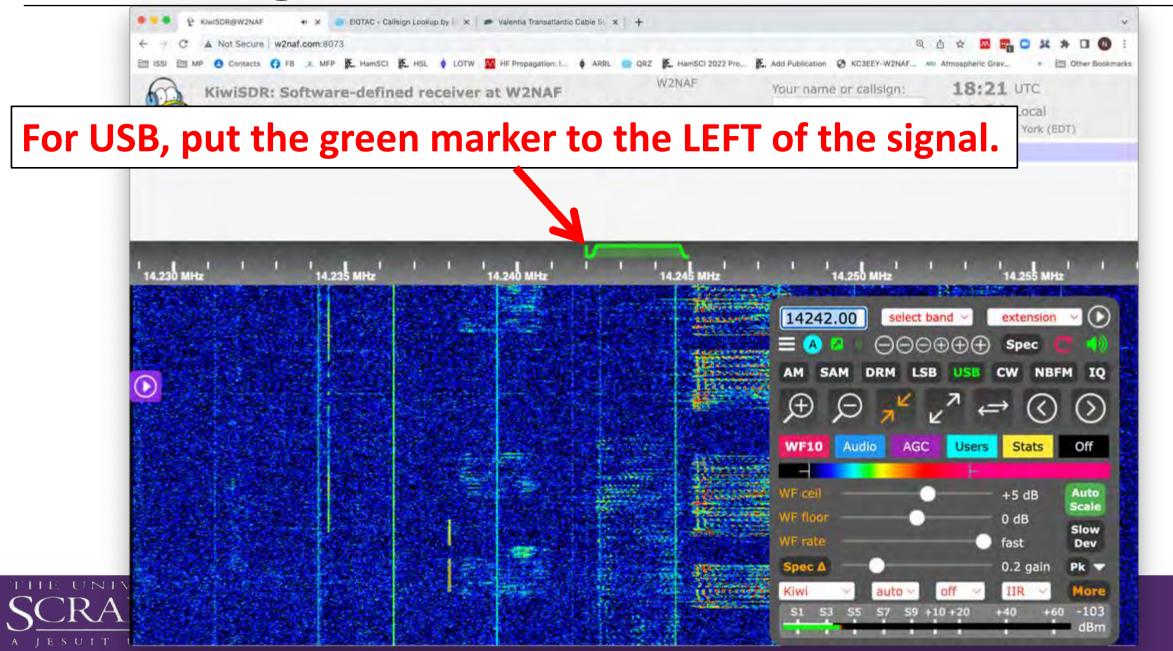
Ham Radio Band Selection



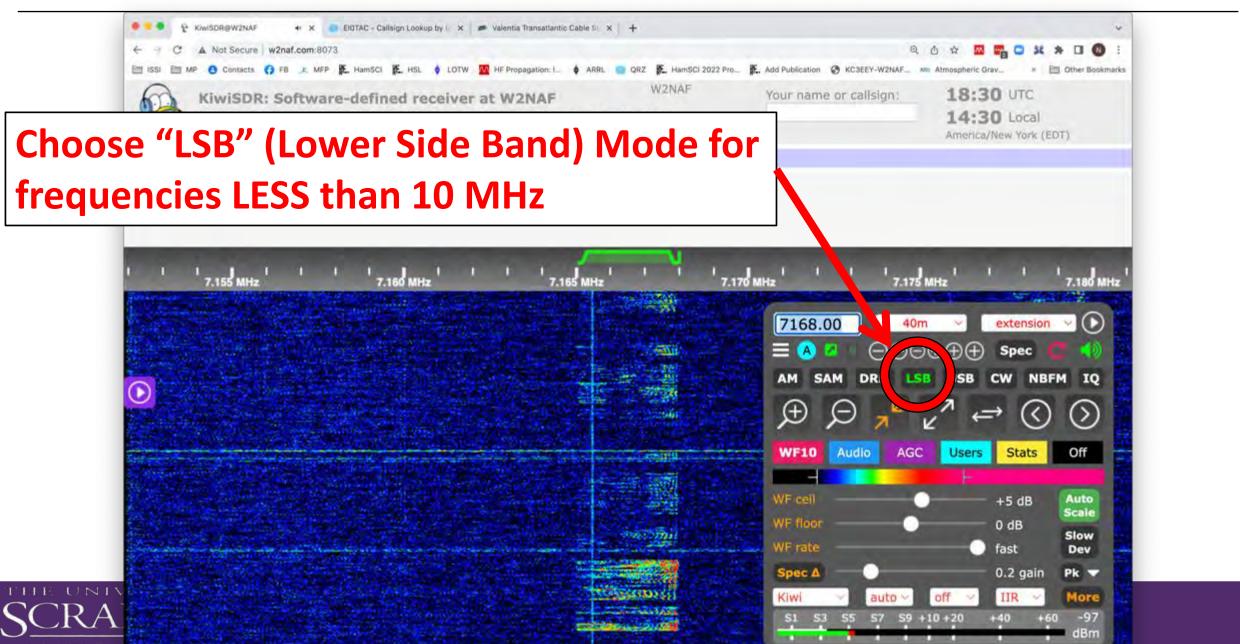
Mode Selection – Higher Bands



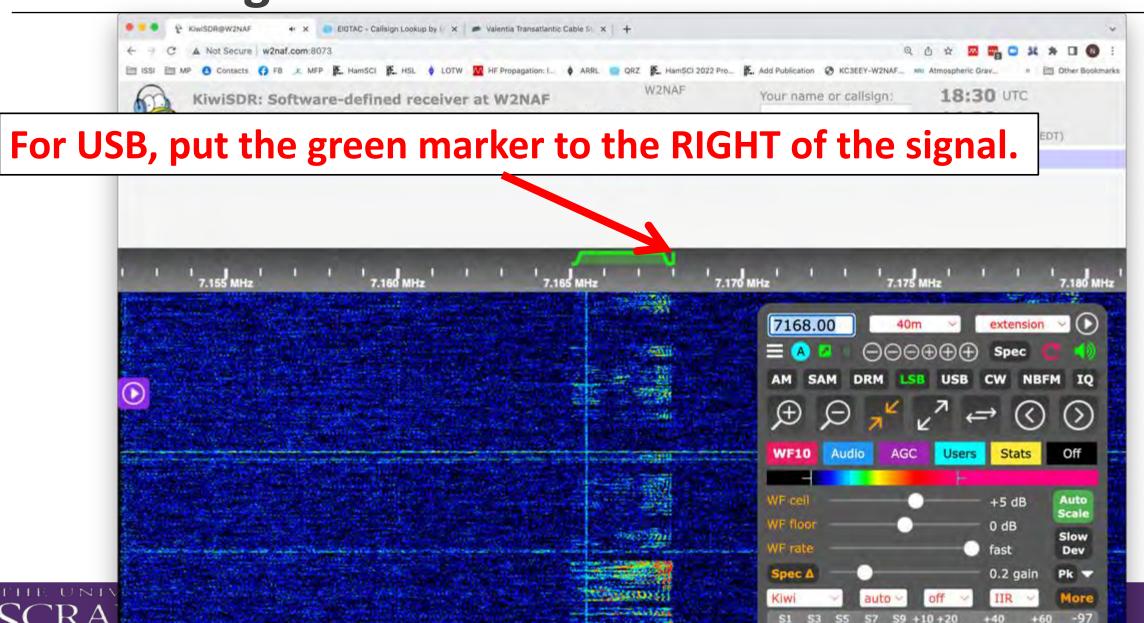
USB Tuning



Mode Selection – Lower Bands



LSB Tuning



Signal Reports – Ham Radio

•HF ham radio operators use the "RST" System

Readability (R)	Signal Strength (S)	
1. Unreadable	1. Faint, signals barely perceptible	
2. Barely readable, occasional words	2. Very weak signals	
distinguishable	2 \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	
3. Readable with considerable difficulty	3. Weak signals	
4. Readable with practically no difficulty	4. Fair signals	
5. Perfectly readable	5. Fairly good signals	
	6. Good signals	
	7. Moderately strong signals	
	8. Strong signals	
	9. Extremely strong signals	

A perfect report is "59".



Phonetic Alphabet



https://hamradioprep.com/



Q-Signals & Ham Radio Codes

Code	Meaning
QSO	A radio contact
QTH	Location
QSL	I confirm.
QRZ?	Who is calling me?
QRT	I'm going off air.
QRP	Low Power
QSY	Changing Frequency
QLF	Please send with left foot
73	Best Wishes
88	Hugs & Kisses



Where to listen... Ham Radio

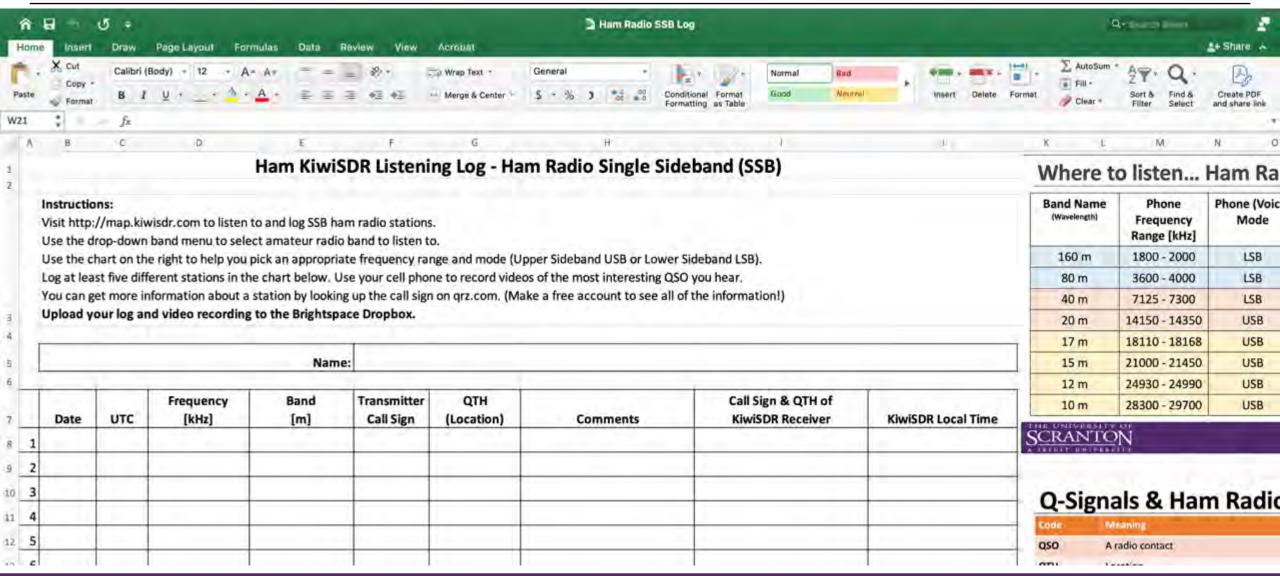
Band Name (Wavelength)	Phone Frequency Range [kHz]	Phone (Voice) Mode	"Best" Time
160 m	1800 - 2000	LSB	Night
80 m	3600 - 4000	LSB	
40 m	7125 - 7300	LSB	Both
20 m	14150 - 14350	USB	
17 m	18110 - 18168	USB	Day
15 m	21000 - 21450	USB	
12 m	24930 - 24990	USB	
10 m	28300 - 29700	USB	

LSB = Lower Side Band USB = Upper Side Band Bandwidth: 3 kHz

Full list of ham radio frequencies available at http://www.arrl.org/graphic al-frequency-allocations



Listening Log



Coordinated Universal Time (UTC)

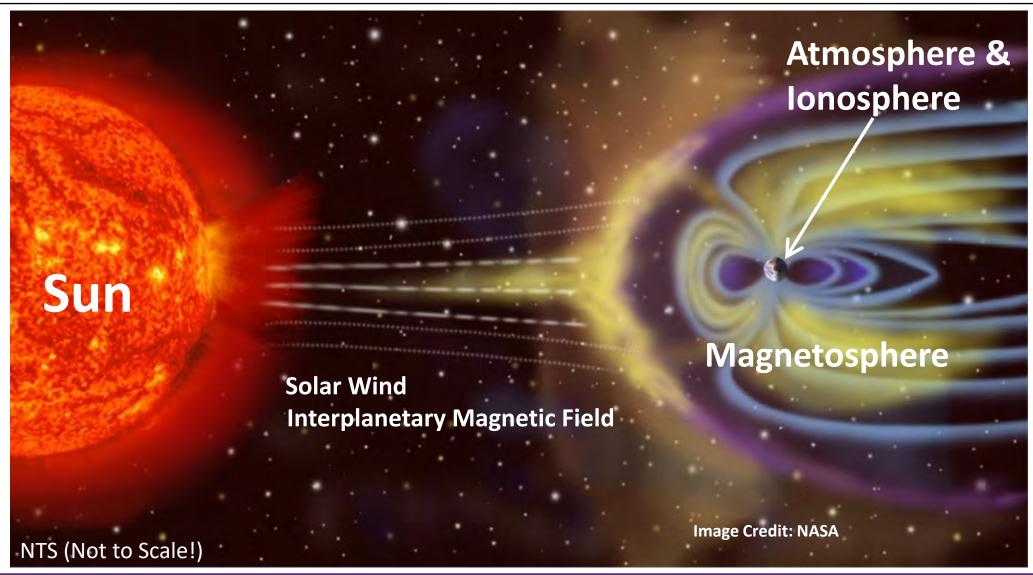
- Ham radio operators, SWLers, and scientists use a single time zone.
- Eastern Standard Time (EST) is 5 hours behind UTC.
- •UTC is always given in 24-hour format.
- You may see it referred to by many names:
 - UT Universal Time
 - UTC Coordinated Universal Time
 - GMT Greenwich Mean Time
 - Zulu (z)
- •Get current UTC time by <u>listening to WWV/WWVH</u> or from https://www.timeanddate.com/worldclock/timezone/utc



Space Weather, Solar Flares, and Shortwave Radio



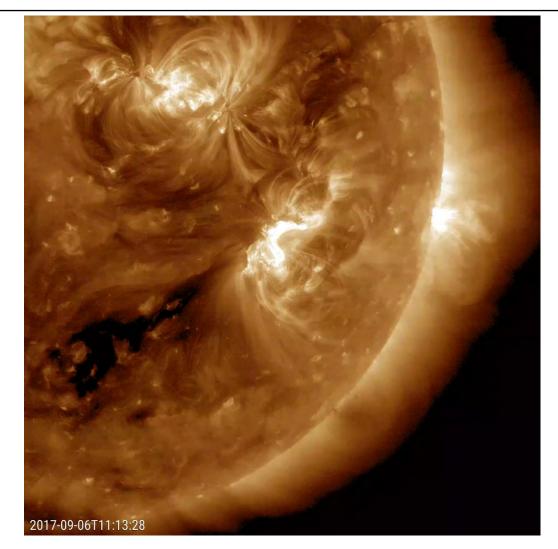
The Geospace System





Solar Activity

- •Solar Activity: All of the violent and variable phenomena in the Sun's atmosphere.
- •Solar activity follows a nominal 11-year/22-year cycle.
- •This is the main driver for all of the space weather we experience on Earth.

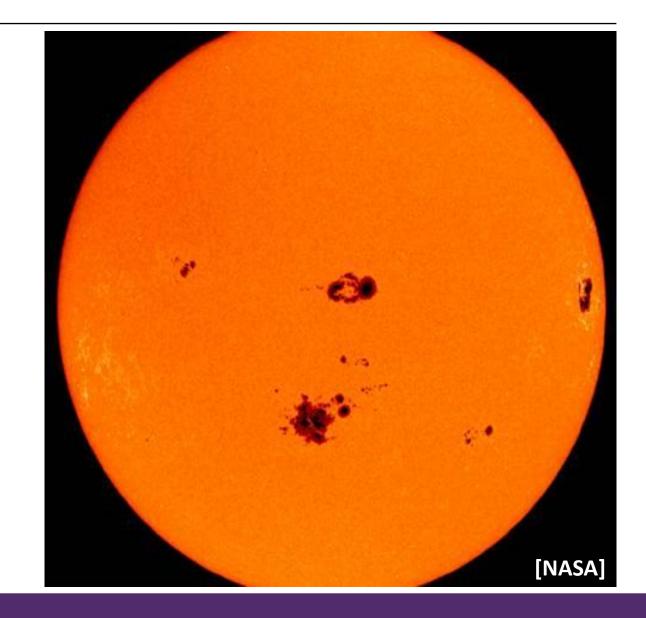


NASA SDO Observation of X9.3 Solar Flare on Sept 6, 2017



Sunspots

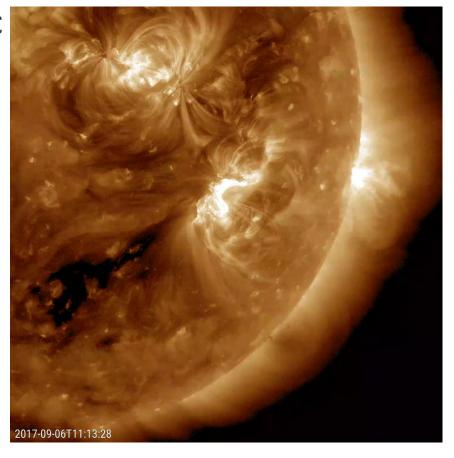
- •Sunspot: Small, darkened regions on the Sun with locally enhanced magnetic fields and relatively cool gas temperatures.
- •Sunspots typically have lifetimes of a few hours to a few months.



Solar Flares

- •Solar flare: Sudden increase in electromagnetic energy from localized regions on the Sun.
- •Energy travels at the speed of light (8 min to Earth)

Solar Flare Parameters				
Occurrence During Solar Max	Several times per day			
Occurrence During Solar Min	Once every week or so			
Energy Released	High-energy UV, X-Rays, and Gamma Ray Photons			
Energy Velocity	Speed of Light			
Energy	Up to $\sim 10^{25}$ J			
Temperature	Up to $\sim 10^7~{ m K}$			

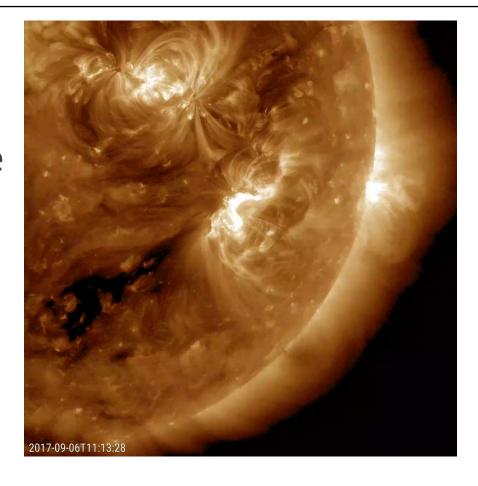


NASA SDO Observation of X9.3 Solar Flare on Sept 6, 2017



Solar Flares

- •Solar flares can cause disruptions to HF radio communications.
- •The soft X-Rays (0.1-0.8 nm) cause enhanced ionization of the D-region (lowest layer of ionosphere).
- •The D region ionosphere is known to absorb, not refract, HF radio waves. This is bad for communications!



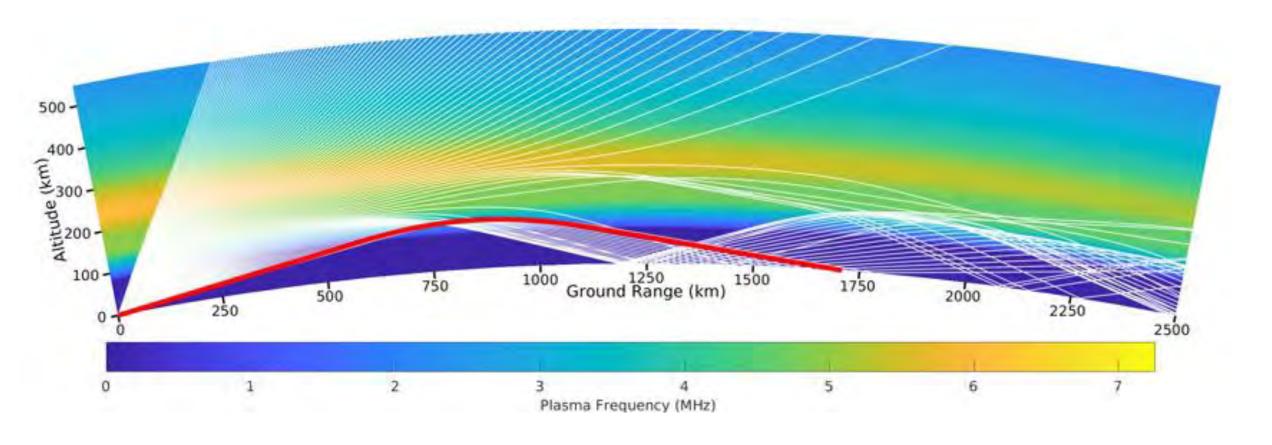
NASA SDO Observation of X9.3 Solar Flare on Sept 6, 2017

Refraction as a Function of Electron Density

14.03 MHz

Eclipsed SAMI3/PHaRLAP Simulation

21 August 2017 • 1600 – 2200 UT 14.03 MHz • TX: AA2MF (Florida) • RX: WE9V (Wisconsin)



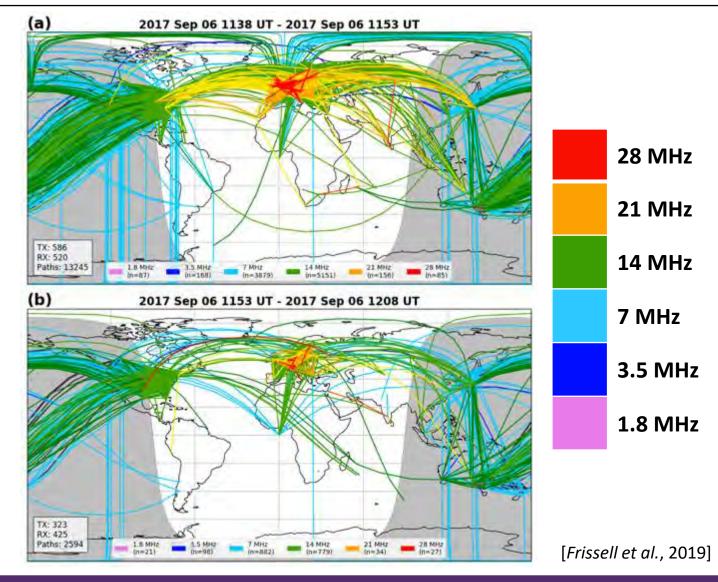


HF Response to Solar Flare

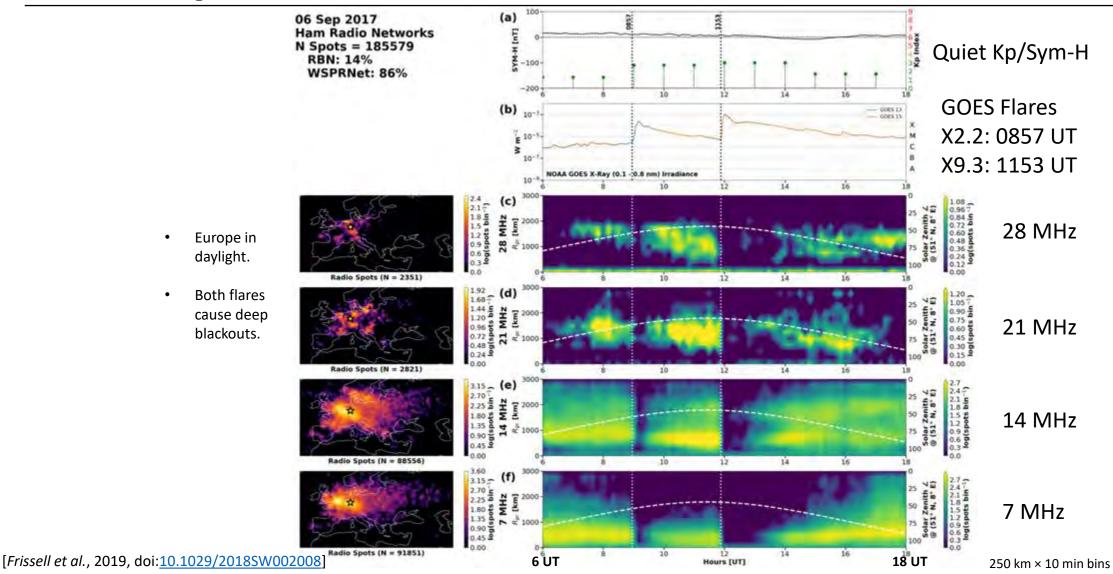
13,245 Paths

6 Sept 2017 1153 UT X9.3 Flare

2,594 Paths



EU Response to Solar Flares





Europe in daylight.

Both flares

cause deep

blackouts.