

# VOACAP – PROPAGATION MODELING

# VOACAP

RADIO WAVES UNITE US



**Feb 10, 2025**

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# VOACAP – PROPAGATION MODELING

## Outline

- What is VOACAP?
- What can VOACAP do?
- What are the model inputs?
- Entering your station information
- Learning by example
- Prop Charts
- Prop Wheel
- Summary

# What is VOACAP?

- **V**oice **O**f **A**merica **C**overage **A**nalysis **P**rogram is a modified version of IONCAP, a shortwave propagation model that has been under development by the U.S. Government since 1942.
- VOACAP's primary purpose is to model shortwave (HF) propagation between two points on the earth's surface.

# What Can VOACAP Do?

- This is a free, online application that allows the user to:
  - Predict best bands and times to work different parts of the world on HF bands
  - Predict best bands and times to work a DXpedition
  - Strategize for a DX contest
  - Review current conditions
  - Visualize on a map the short/long path between two stations, including the midpoint. For example, you might quickly see why you are not able to work Europe during auroral conditions (the short path may traverse the auroral oval).
  - See how changing antenna and power parameters affects probabilities of working the target station
  - Swap TX and RX locations to see discrepancies in non-reciprocal paths, differences in antennas, power levels, and noise.
  - Visualize grayline terminator

# What Are the Inputs?

1. Transmitter Info: Freq, Power, Ant Type/height/orientation
2. Receiver Info: Similar to Transmitter info but also includes min SNR for reliable communication
3. Path Info: Great circle between TX and RX, Time (UTC), Date
4. Solar and Geomagnetic Data (SSN, Kp)
5. Ionospheric Parameters (Built-in Int'l Reference Ionosphere, MUF – calculated for path and time)
6. Operating Mode – point to point or larger area of coverage, polarization (vertical, horizontal, circular of transmitted signal)
7. Environmental Noise – atmospheric, man-made, galactic – at RX location
8. Other – Modulation Type (bandwidth), Reliability and Signal Strength Parameters for reliability and performance

# The Main Screen

Left-Side Controls:

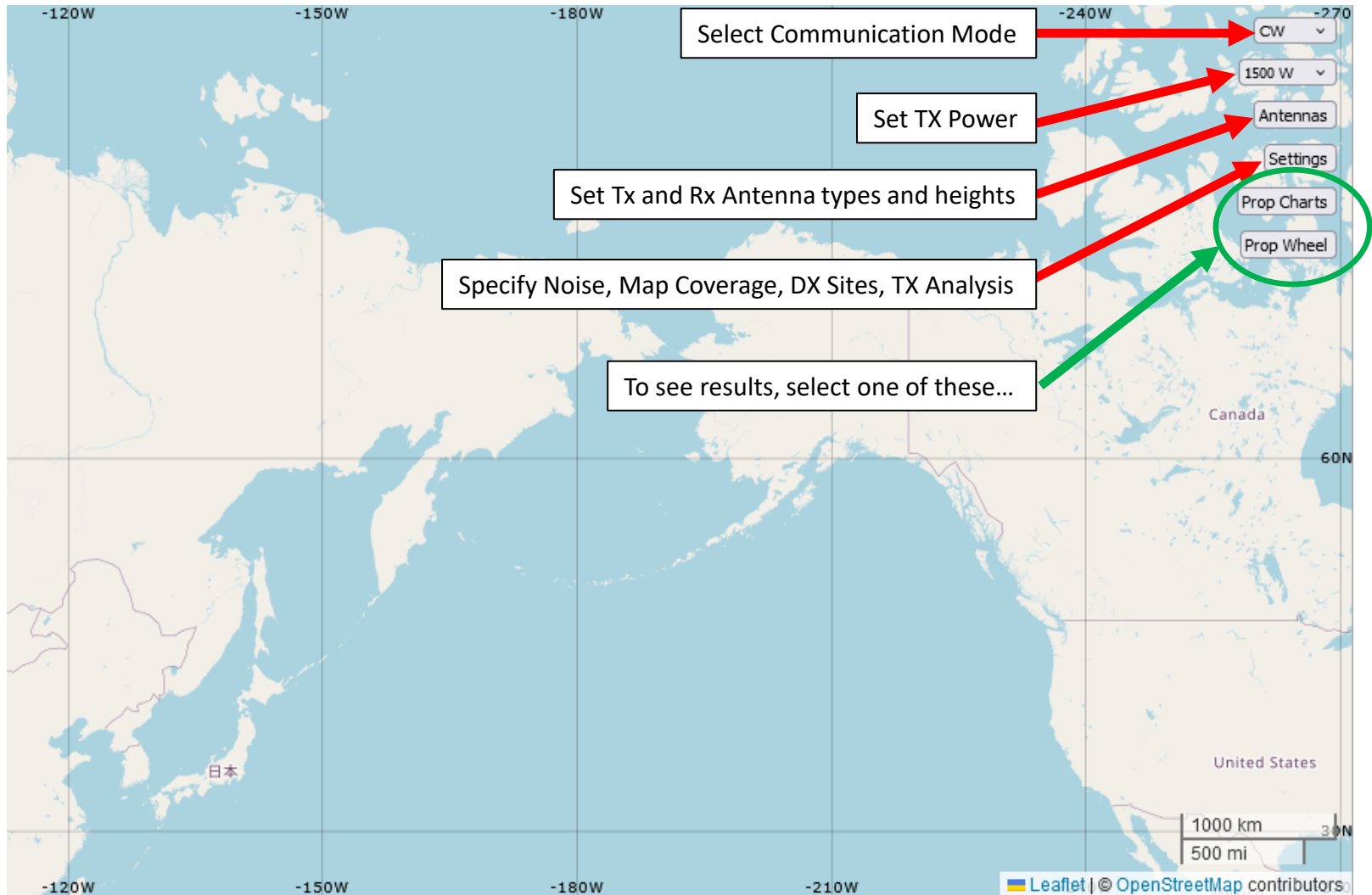


Set Home: Saves your home station TX and RX location, antenna configurations as a cookie (no need to re-enter this information every time you visit).

NoEs: Toggles Sporadic-E layer off/on (default is off) for summer months

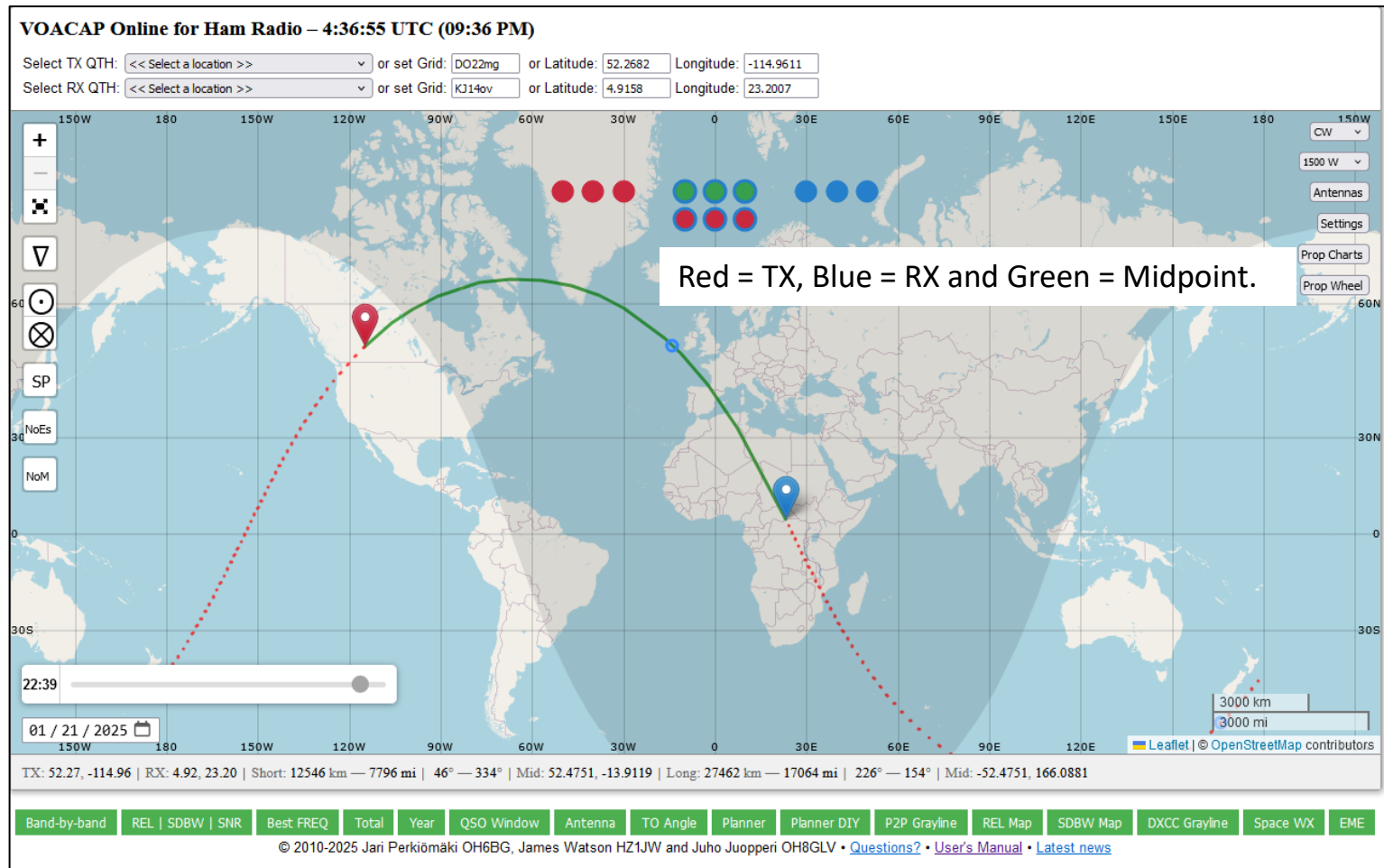
# The Main Screen

## Right-Side Controls:



# The Main Screen

What are those red, green and blue dots at the top of the map?



- Left dot = sunrise, middle dot = sunset, right dot = midnight: for TX, RX and Midpoint Locations
- Blue-bordered dots for short-path or long-path midpoints

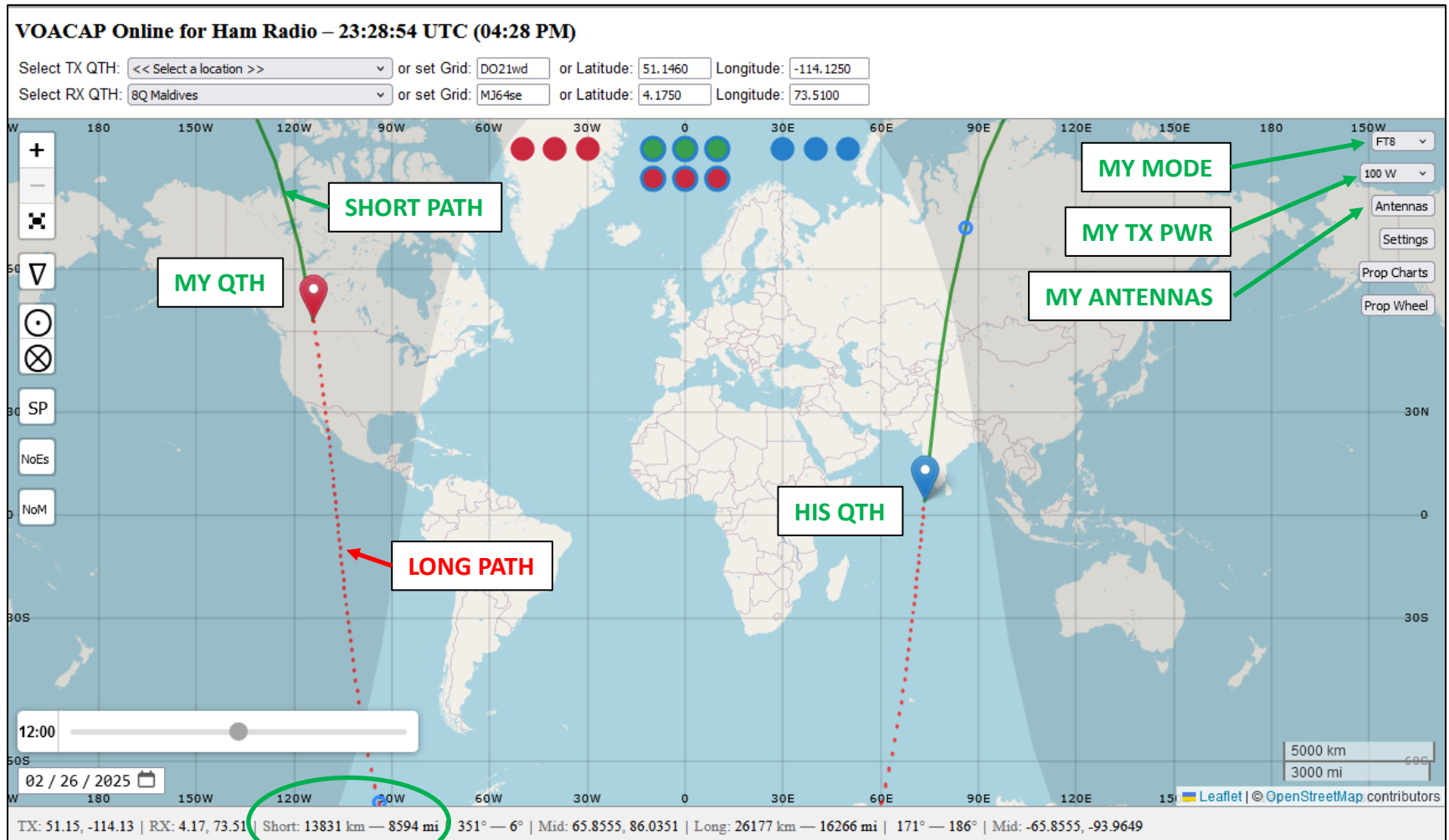
# Let's Work Through an Example

DXpedition 8Q7FL has been announced for Feb 26 to Mar 6. Supposing I have never worked the Maldives on any band, this would be an “ATNO” (All Time New One) for me. How can I use VOACAP in order to improve my chances of working them on any band? On more than one band? And what about modes? How do my chances change with different power and antennas?

# Example: Where, How, When

- Start VOACAP by selecting: <https://www.voacap.com/hf/>
- Enter your grid square to the right of “Select TX QTH”
- Select “8Q Maldives” in drop down box beside “Select RX QTH”
- Enter your preferred mode (CW in this case) at top right
- Enter your transmit power by selecting from choices below mode (1500W)
- Complete the Antennas menu for each band you operate
- Ignore “Settings” at right (for now) – Defaults offer a good starting point
- Enter the date you wish to model at bottom left (Feb 26, in this case)
- Save current settings for later use by clicking on circle with dot in the center on the left side of the map display

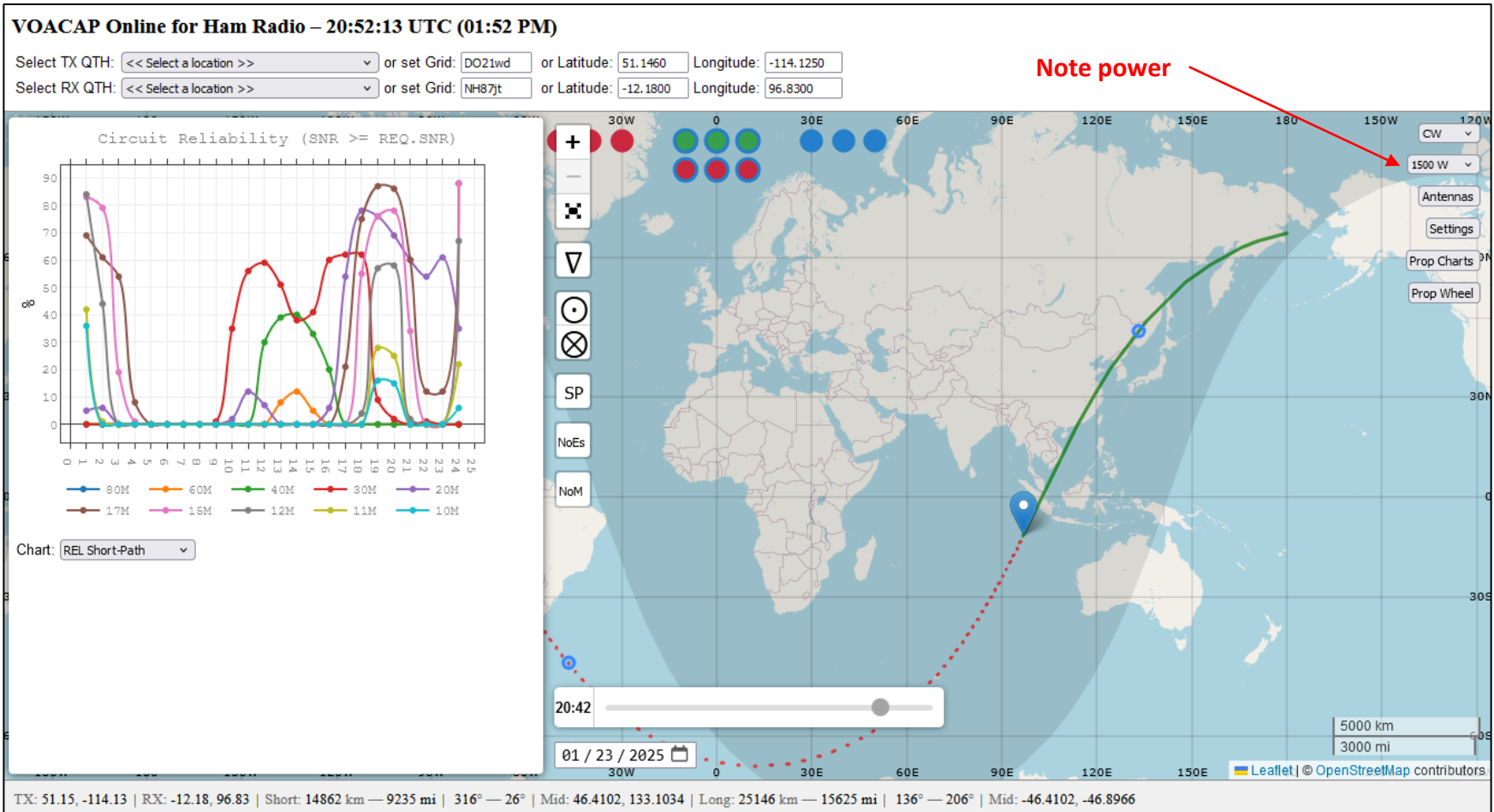
# Example: Where, How, When?



Note distances

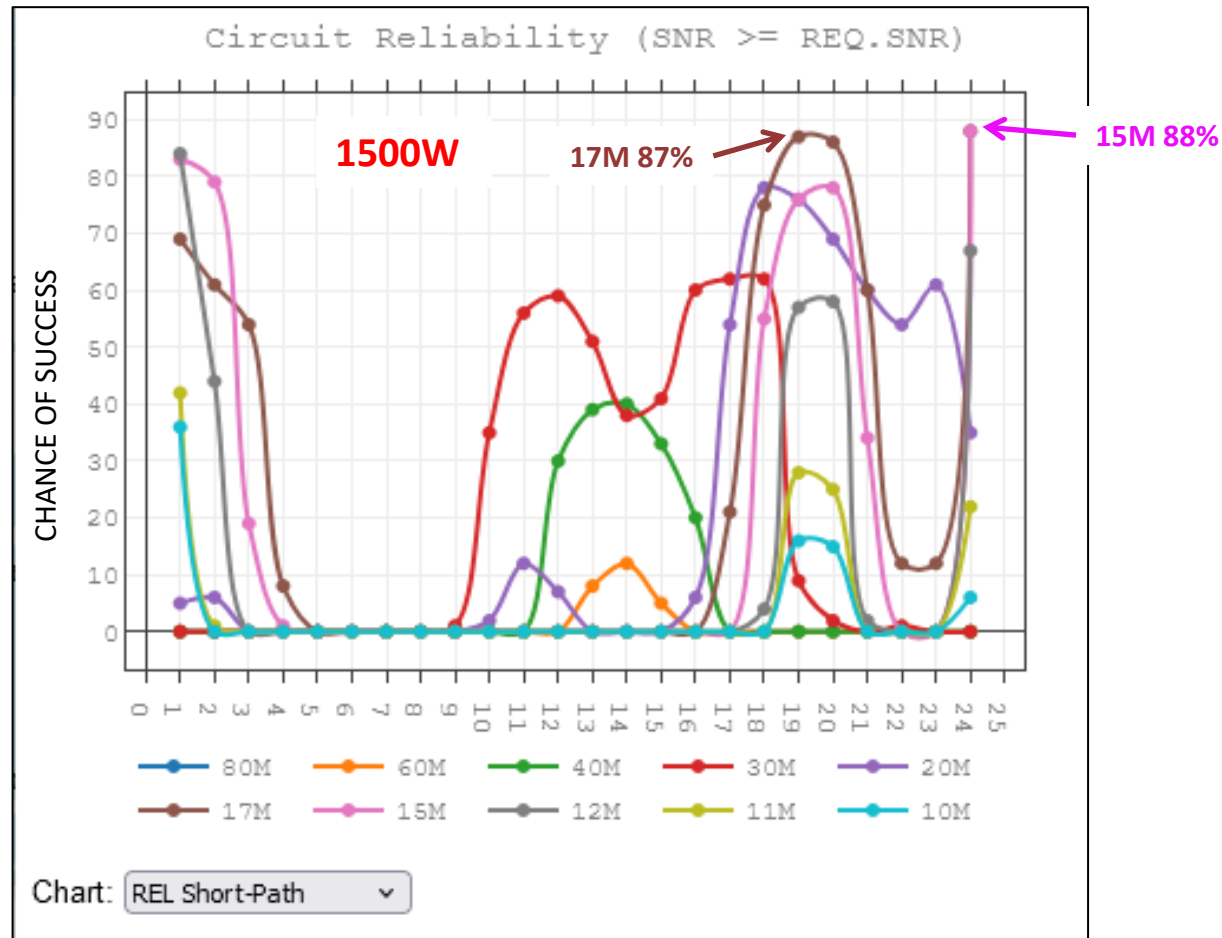
Note azimuth

# PROP CHARTS OUTPUT



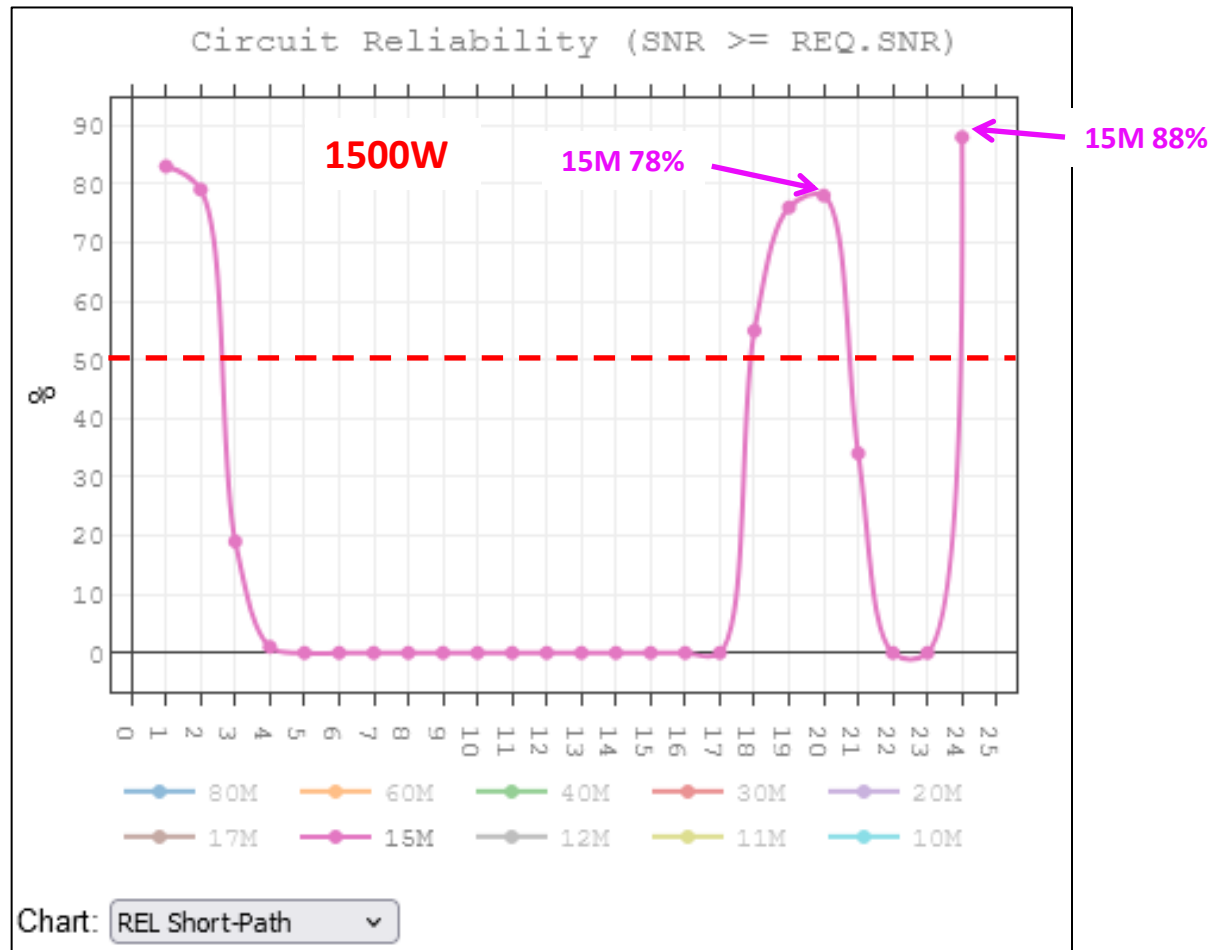
- DEFAULT: SHOWS ALL BANDS FOR SHORT PATH
- IMMEDIATELY SHOWS BEST BAND AND BEST TIME WINDOW ALONG WITH  $P_{\text{SUCCESS}}$
- CLICKING ON LEGEND AT BOTTOM OF CHART TOGGLES THAT BAND ON/OFF

# PROP CHARTS OUTPUT – ZOOM IN



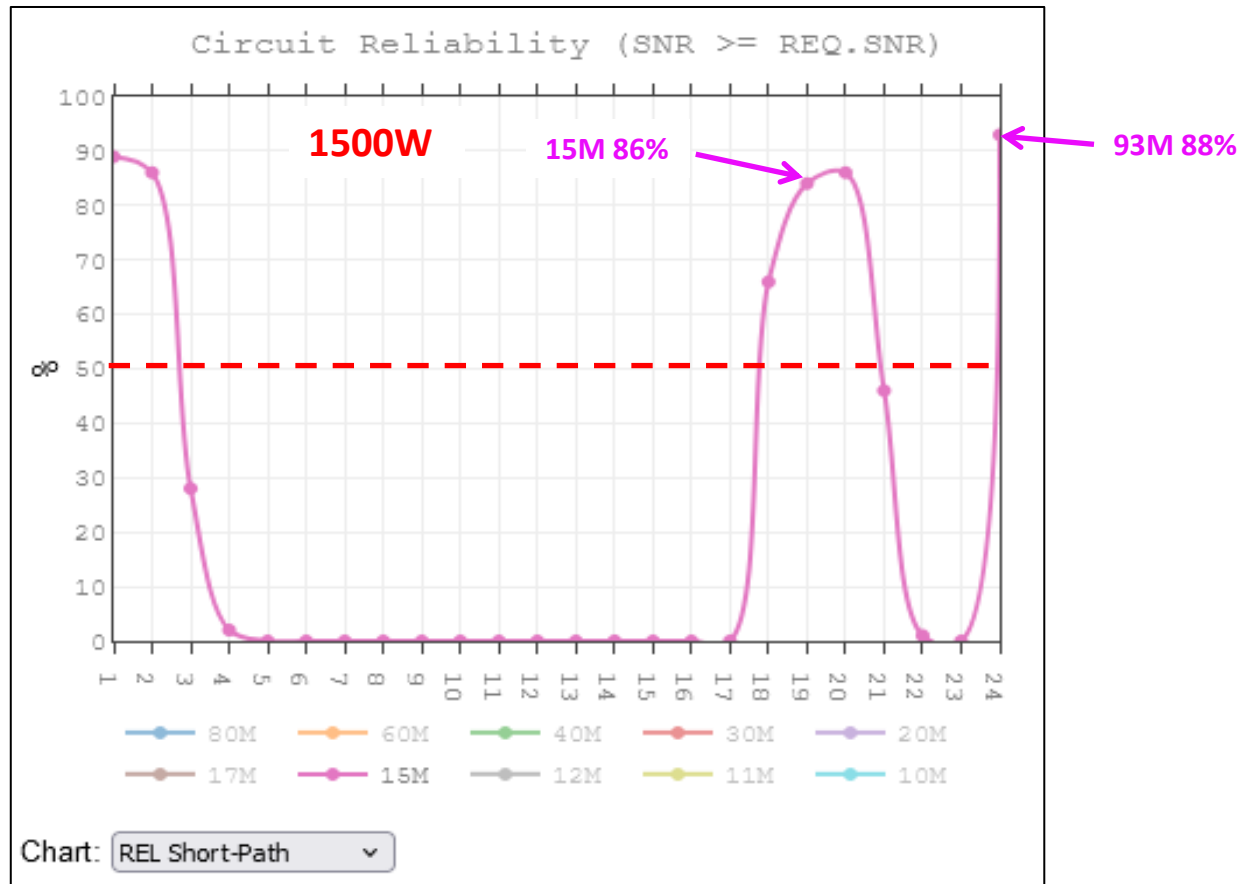
- Best chance to work them is on 15m with 88% COS at 0000 UTC
- Second best chance is on 17m WITH 87% COS at 1900 UTC
- Best chance on 20m is 78% COS at 1800 UTC

# PROP CHARTS OUTPUT – 15m Band Only - CW



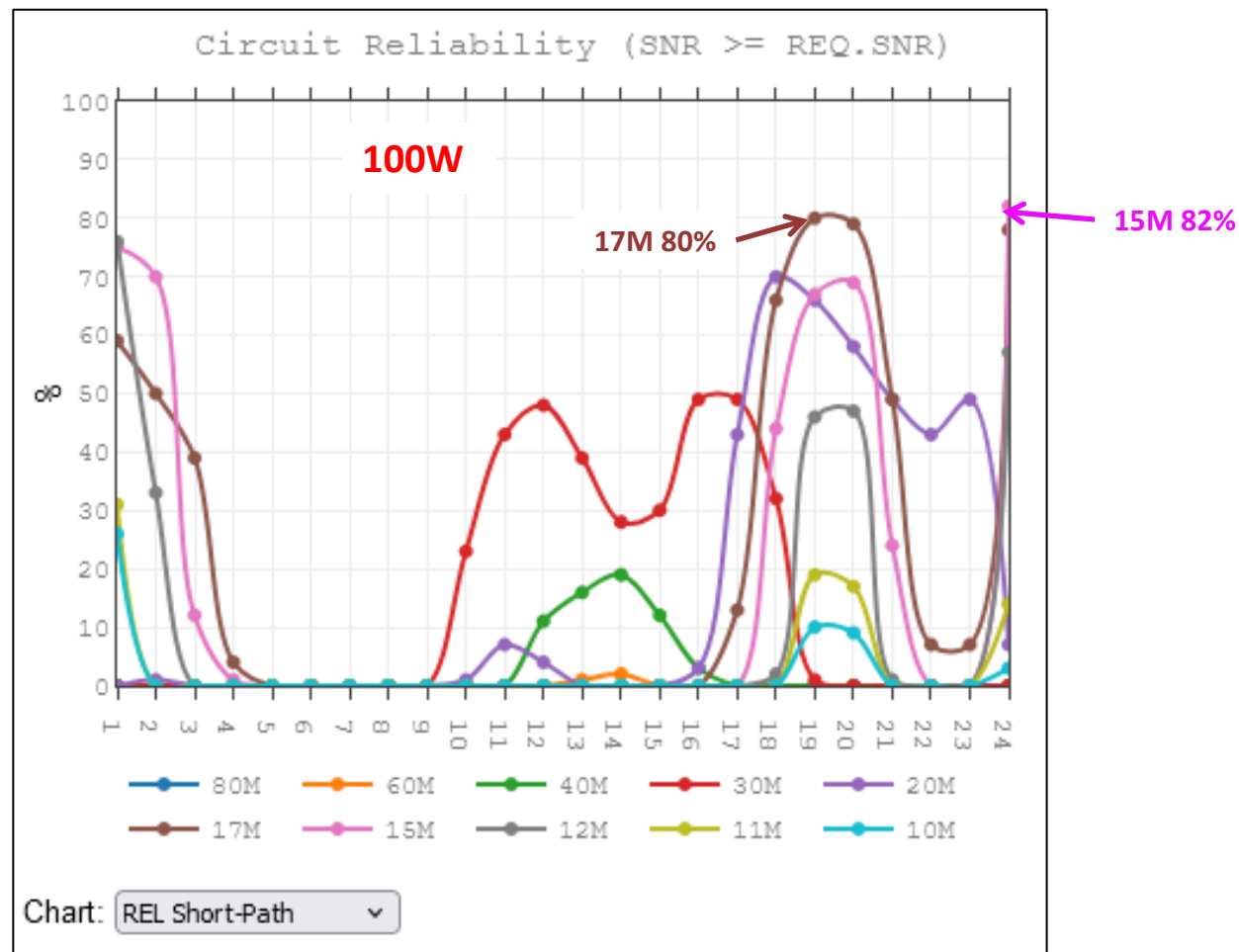
- Clicked on all bands except 15m to turn everything else off
- Demonstrates two windows with  $> 50\%$  COS: 0000 – 0230 UTC and 1800 – 2030 UTC

# PROP CHARTS OUTPUT – 15m Band Only – FT8



- Clicked on all bands except 15m to turn everything else off
- Demonstrates two windows with > 50% COS: 0000 – 0245 UTC and 1800 – 2100 UTC

# PROP CHARTS OUTPUT – 15m Band Only – FT8 100W



- 15M 82% COS @ 100W compared to 93% COS @ 1500W
- 17M 80% COS @ 100W compared to 87% COS @ 1500W

# What Were Default Antennas?

 Transmitter Site

TX antennas:

|      |                       |   |
|------|-----------------------|---|
| 10M: | 2-el Yagi @ 5M (17ft) | ▼ |
| 12M: | 2-el Yagi @ 5M (17ft) | ▼ |
| 15M: | 2-el Yagi @ 5M (17ft) | ▼ |
| 17M: | 2-el Yagi @ 5M (17ft) | ▼ |
| 20M: | 2-el Yagi @ 5M (17ft) | ▼ |
| 30M: | 1/4 wl GP Gd Gnd      | ▼ |
| 40M: | 1/4 wl GP Gd Gnd      | ▼ |
| 60M: | 1/4 wl GP Gd Gnd      | ▼ |
| 80M: | 1/4 wl GP Gd Gnd      | ▼ |

 Receiver Site

RX antennas:

|      |                       |   |
|------|-----------------------|---|
| 10M: | 2-el Yagi @ 5M (17ft) | ▼ |
| 12M: | 2-el Yagi @ 5M (17ft) | ▼ |
| 15M: | 2-el Yagi @ 5M (17ft) | ▼ |
| 17M: | 2-el Yagi @ 5M (17ft) | ▼ |
| 20M: | 2-el Yagi @ 5M (17ft) | ▼ |
| 30M: | Dipole @ 5M (17ft)    | ▼ |
| 40M: | Dipole @ 5M (17ft)    | ▼ |
| 60M: | Dipole @ 5M (17ft)    | ▼ |
| 80M: | Dipole @ 5M (17ft)    | ▼ |

Swap TX/RX antennas

Looks like typical Hexbeam and Vertical antennas at both sites!

# Let's Change Antennas and Rerun for FT8 – 100W

 Transmitter Site

TX antennas:

|      |                        |   |
|------|------------------------|---|
| 10M: | 2-el Yagi @ 10M (33ft) | ▼ |
| 12M: | Dipole @ 10M (33ft)    | ▼ |
| 15M: | 2-el Yagi @ 10M (33ft) | ▼ |
| 17M: | Dipole @ 10M (33ft)    | ▼ |
| 20M: | 2-el Yagi @ 10M (33ft) | ▼ |
| 30M: | Dipole @ 10M (33ft)    | ▼ |
| 40M: | 1/4 wl GP Gd Gnd       | ▼ |
| 60M: | 1/4 wl GP Gd Gnd       | ▼ |
| 80M: | 1/4 wl GP Gd Gnd       | ▼ |

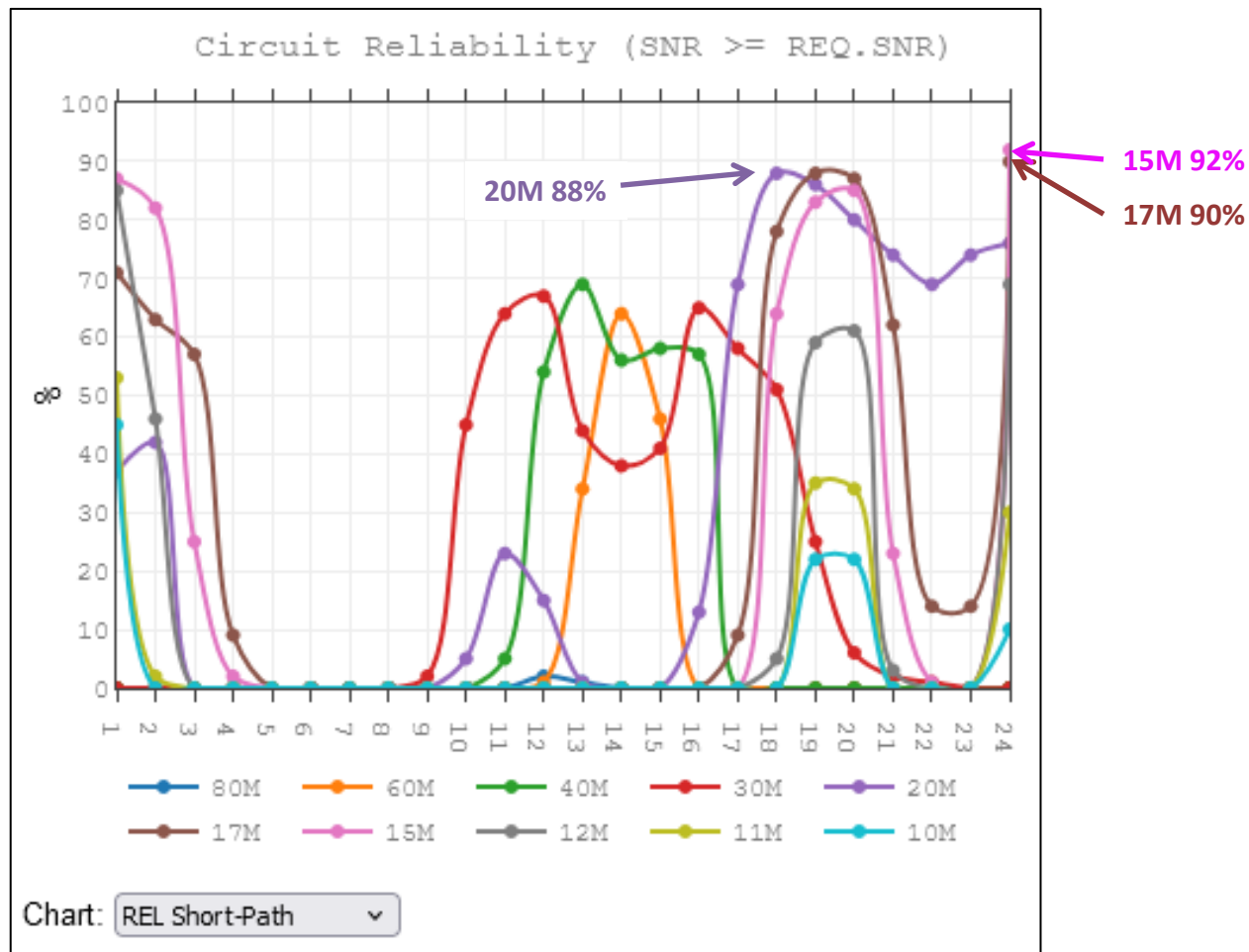
 Receiver Site

RX antennas:

|      |                        |   |
|------|------------------------|---|
| 10M: | 2-el Yagi @ 10M (33ft) | ▼ |
| 12M: | 2-el Yagi @ 10M (33ft) | ▼ |
| 15M: | 2-el Yagi @ 10M (33ft) | ▼ |
| 17M: | 2-el Yagi @ 10M (33ft) | ▼ |
| 20M: | 2-el Yagi @ 15M (50ft) | ▼ |
| 30M: | 1/4 wl GP Vy Gd Gnd    | ▼ |
| 40M: | 1/4 wl GP Vy Gd Gnd    | ▼ |
| 60M: | 1/4 wl GP Vy Gd Gnd    | ▼ |
| 80M: | 1/4 wl GP Vy Gd Gnd    | ▼ |

Swap TX/RX antennas

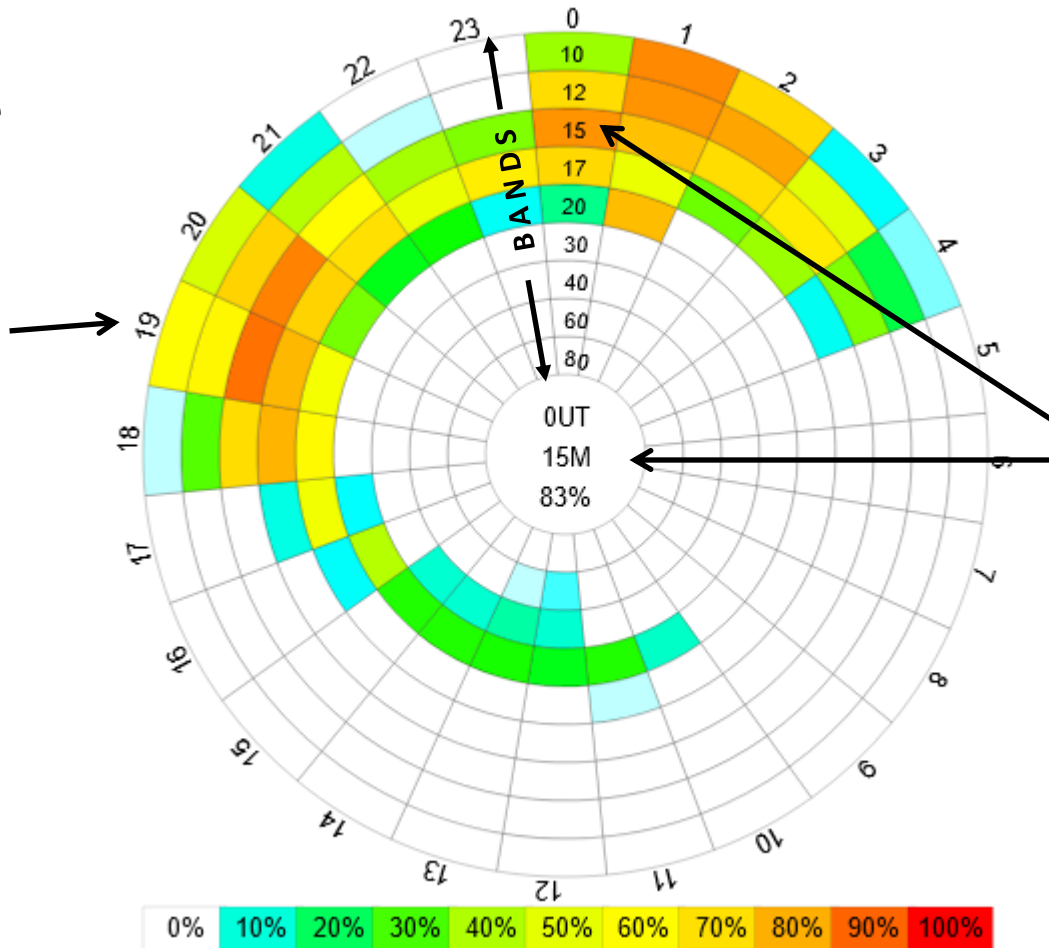
# PROP CHARTS OUTPUT – All Bands – FT8 100W



- 20M Band improved a lot (78 COS to 88% COS) , mainly due to doubling height

# PROP WHEEL OUTPUT – All Bands – FT8 100W

Note: Each time slot starts in earlier time.  
Example: This is 1800-1900 UTC.



Values in center of wheel reflect values of cursor position within the outer spokes/cells of the wheel.

**Easier to visualize options for best bands and time windows**

# BEST FREQUENCY LISTING\*

Feb 2025 SSN = 109. Minimum Angle= 3.000 degrees  
 DO21wd NH87t AZIMUTHS N. MI. KM  
 51.15 N 114.12 W - 12.18 S 96.83 E 316.00 26.47 8023.4 14858.2  
 REQ.SNR = 13 dB, TX POWER = 0.08 kW, SHORT-PATH



## SDBW:

MEDIAN SIGNAL  
POWER AT RX IN  
dB REL 1W

dBW values range  
from -164 to -103  
(S9) where 1 S-  
meter reading =  
6dB

## FOT:

Frequency of  
Optimum Traffic  
(most reliable)

The best operating frequencies (FREQ1, FREQ2, FREQ3) by hour

| UTC | SDBW      | ΔSIG  | REL | SNR  | ΔSNR  | MUFday | FOT  | MUF  | HPF  | FREQ1 | FREQ2 | FREQ3 |
|-----|-----------|-------|-----|------|-------|--------|------|------|------|-------|-------|-------|
| 01  | -145 (S2) | 39.6  | 83% | 33   | 42.5  | 72%    | 21.8 | 27.6 | 30.6 | 24.9  | 28.2  | 21.1  |
| 02  | -147 (S2) | 41.0  | 81% | 31   | 42.9  | 62%    | 20.7 | 26.2 | 29.1 | 24.9  | 21.1  | 28.2  |
| 03  | -153 (S1) | 39.1  | 67% | 22   | 41.1  | 72%    | 18.5 | 23.4 | 25.9 | 21.1  | 18.1  | 24.9* |
| 04  | -171 (--) | 50.0* | 35% | 5    | 52.6* | 28%    | 15.5 | 18.9 | 23.8 | 21.1* | 18.1- | 24.9- |
| 05  | -220 (--) | 50.0* | 0%  | -44  | 52.6* | 1%     | 11.6 | 14.2 | 17.9 | 21.1- | 18.1- | 14.1- |
| 06  | -281 (--) | 50.0* | 0%  | -108 | 51.5* | 0%     | 8.9  | 10.8 | 13.6 | 18.1- | 14.1- | 28.2- |
| 07  | -269 (--) | 45.7  | 0%  | -104 | 48.3* | 42%    | 8.0  | 9.7  | 12.2 | 10.1- | 14.1- | 28.2- |
| 08  | -239 (--) | 50.0* | 0%  | -74  | 52.5* | 27%    | 6.9  | 9.0  | 11.3 | 10.1- | 14.1- | 7.1-  |
| 09  | -209 (--) | 47.9* | 0%  | -46  | 49.6* | 31%    | 7.1  | 9.2  | 11.6 | 10.1- | 7.1-  | 14.1- |
| 10  | -172 (--) | 48.3* | 12% | -9   | 51.1* | 45%    | 7.6  | 9.9  | 12.4 | 10.1- | 7.1-  | 14.1- |
| 11  | -160 (S0) | 49.4* | 27% | 1    | 52.4* | 52%    | 7.8  | 10.2 | 12.8 | 10.1  | 7.1-  | 14.1- |
| 12  | -155 (S0) | 32.4  | 11% | 2    | 37.5  | 95%    | 7.7  | 9.8  | 12.1 | 7.1   | 10.1- | 5.4-  |
| 13  | -152 (S1) | 33.8  | 15% | 4    | 38.5  | 92%    | 7.3  | 9.3  | 11.5 | 7.1   | 5.4   | 10.1- |
| 14  | -152 (S1) | 33.9  | 11% | 3    | 36.8  | 92%    | 7.3  | 9.3  | 11.5 | 7.1   | 5.4   | 10.1- |
| 15  | -150 (S2) | 30.8  | 11% | 5    | 33.6  | 95%    | 7.7  | 9.8  | 12.1 | 7.1   | 10.1  | 5.4-  |
| 16  | -151 (S1) | 41.8  | 41% | 10   | 43.2  | 72%    | 9.0  | 11.1 | 13.7 | 10.1  | 7.1-  | 14.1- |
| 17  | -155 (S0) | 50.0* | 53% | 15   | 52.4* | 48%    | 11.3 | 14.0 | 17.3 | 14.1  | 10.1+ | 18.1- |
| 18  | -144 (S3) | 46.9  | 79% | 30   | 49.5* | 61%    | 15.3 | 18.9 | 23.4 | 18.1  | 21.1  | 14.1  |
| 19  | -138 (S4) | 45.6  | 88% | 38   | 48.4* | 63%    | 18.0 | 22.2 | 27.6 | 21.1  | 18.1  | 14.1  |
| 20  | -141 (S3) | 47.3* | 85% | 35   | 49.9* | 61%    | 16.9 | 22.2 | 27.8 | 21.1  | 18.1  | 24.9  |
| 21  | -150 (S2) | 45.6  | 70% | 24   | 48.3* | 65%    | 14.8 | 19.5 | 24.4 | 18.1  | 21.1  | 14.1  |
| 22  | -160 (S0) | 50.0* | 52% | 14   | 52.6* | 39%    | 13.0 | 17.1 | 21.4 | 18.1  | 14.1* | 21.1* |
| 23  | -152 (S1) | 48.1* | 66% | 22   | 50.7* | 61%    | 16.5 | 18.5 | 21.1 | 18.1  | 14.1* | 21.1  |
| 24  | -143 (S3) | 34.7  | 83% | 33   | 38.1  | 91%    | 21.2 | 23.8 | 27.2 | 21.1  | 24.9  | 18.1  |

[View the prediction as text.](#)

# GENERAL PROPAGATION SETTINGS - DEFAULT

General Propagation Settings

Noise:  SSN:  Dyn SSN? ☐

Method:  Min.TOA:

Coverage Area Map Settings

Band:  UTC:  Range:  hrs

Propagation Planner Settings

DX sites: ☒ CQ Zones ☐ DXCC Asia  
☐ ITU Zones ☐ DXCC Europe  
☐ DXCC All Continents ☐ DXCC North America  
☐ DXCC Africa ☐ DXCC Oceania  
☐ DXCC Antarctica ☐ DXCC South America

TX Antenna Analysis Settings

Sets: ☒ Dipoles ☐ Vertical vs ants @10m AGL  
☐ Verticals, high dipoles ☐ Vertical vs ants @20m AGL  
☐ 3-el Yagis ☐ Vertical vs ants @40m AGL  
☐ 5-el Yagis ☐ Vertical vs ants @60m AGL  
☐ 7-el Yagis

Take-off Angle Analysis Settings

Period: ☒ Year ☐ Month

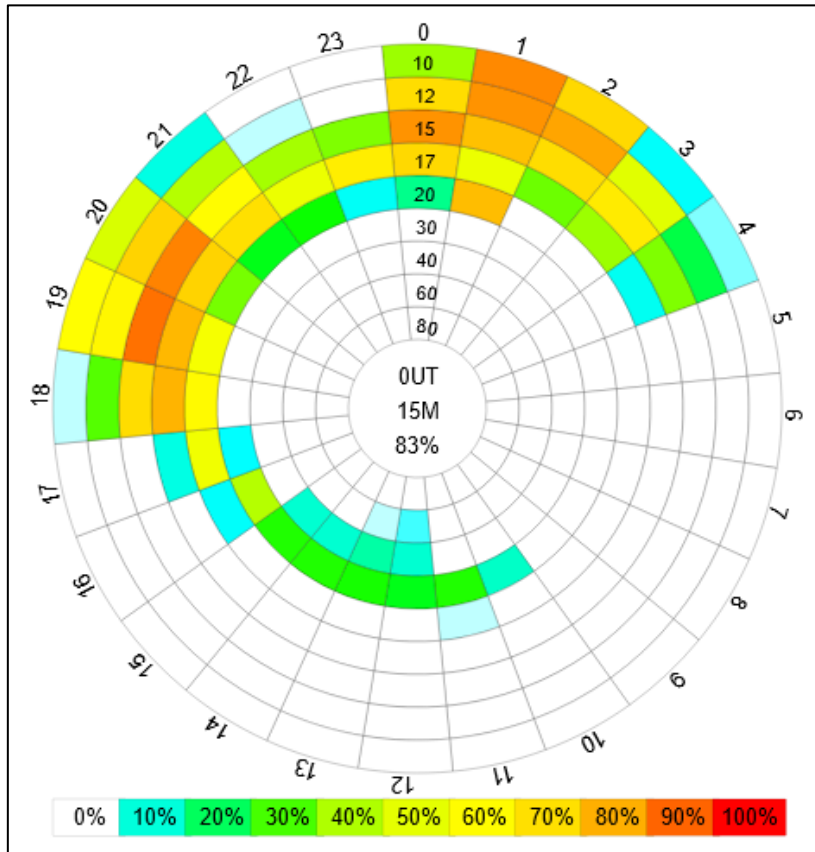
If we check this box we will use 3 day moving average of SSN for the current month. However, this does not affect the following month (we are looking at Feb 26, 2025).

So let's change the SSN to today's number (on Jan 23, 2025 the value is 169).

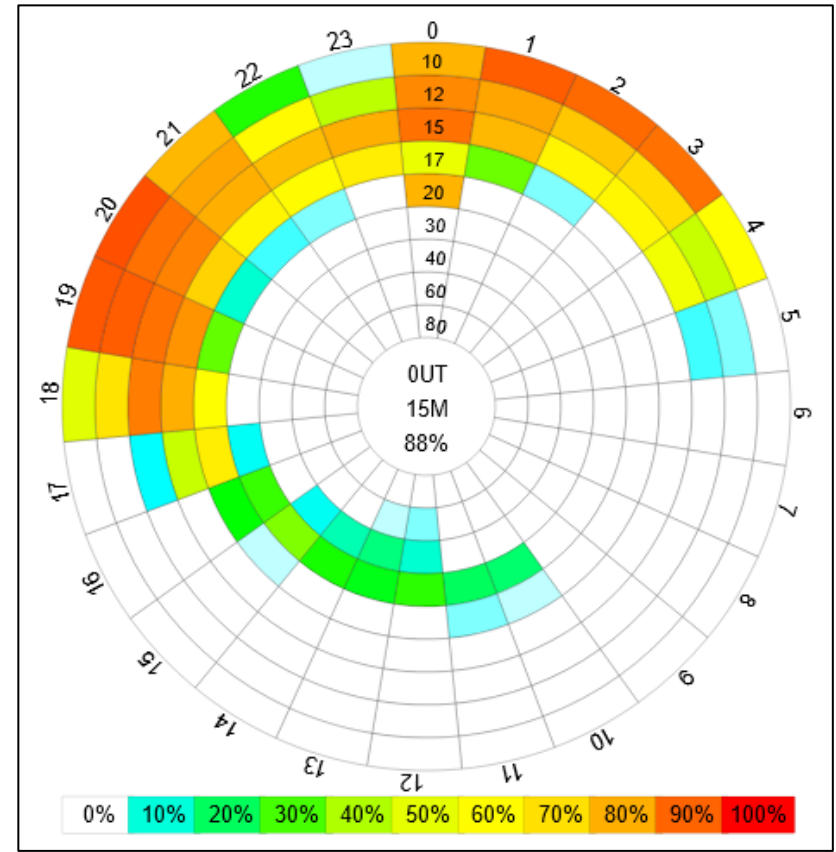
THESE SETTINGS WERE USED TO CREATE ALL MODELS SHOWN SO FAR

# PROP WHEEL OUTPUT – All Bands – FT8 100W

DEFAULT SSN (109)

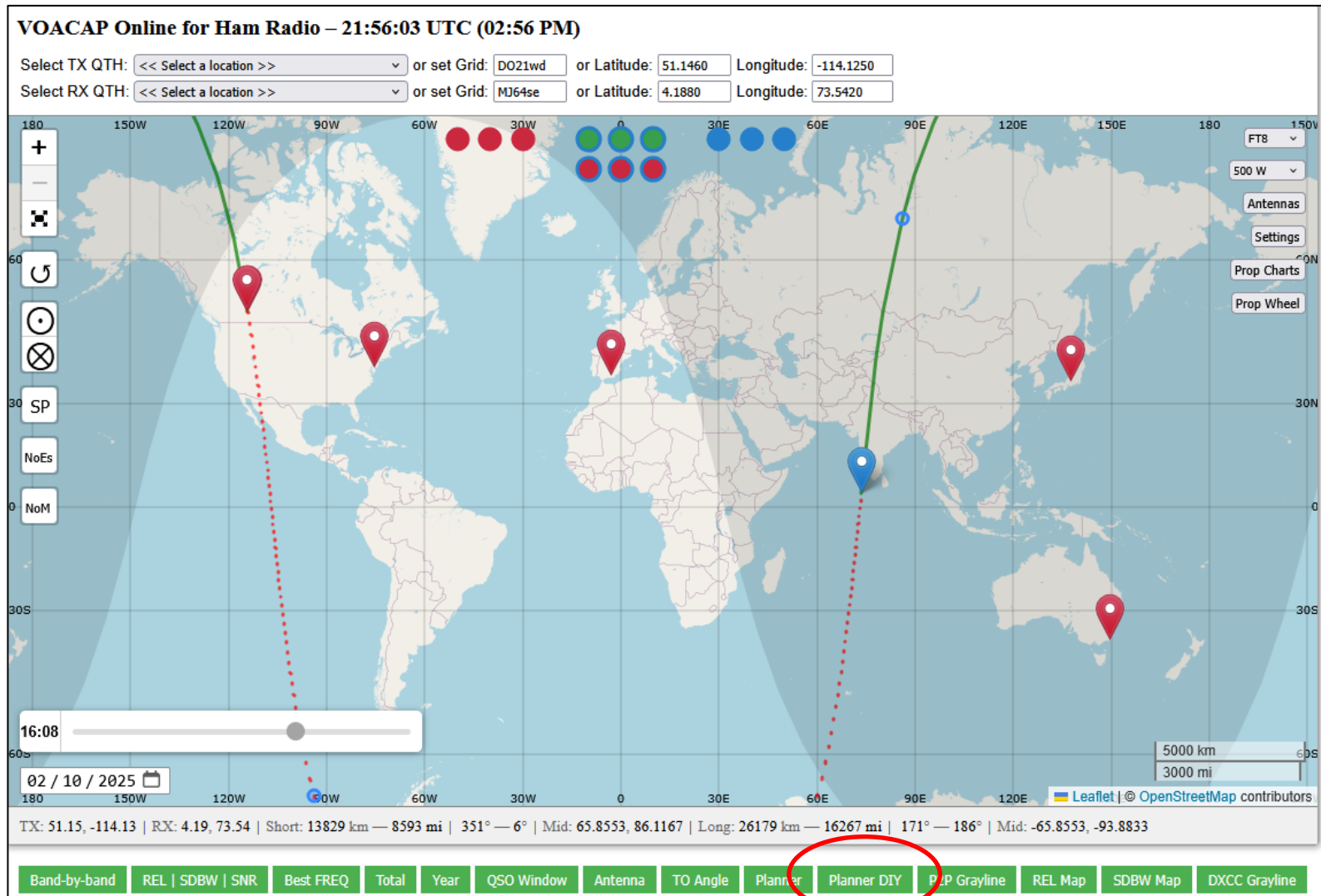


USING TODAY'S SSN (169)



**Much improved chance of working on 10m**

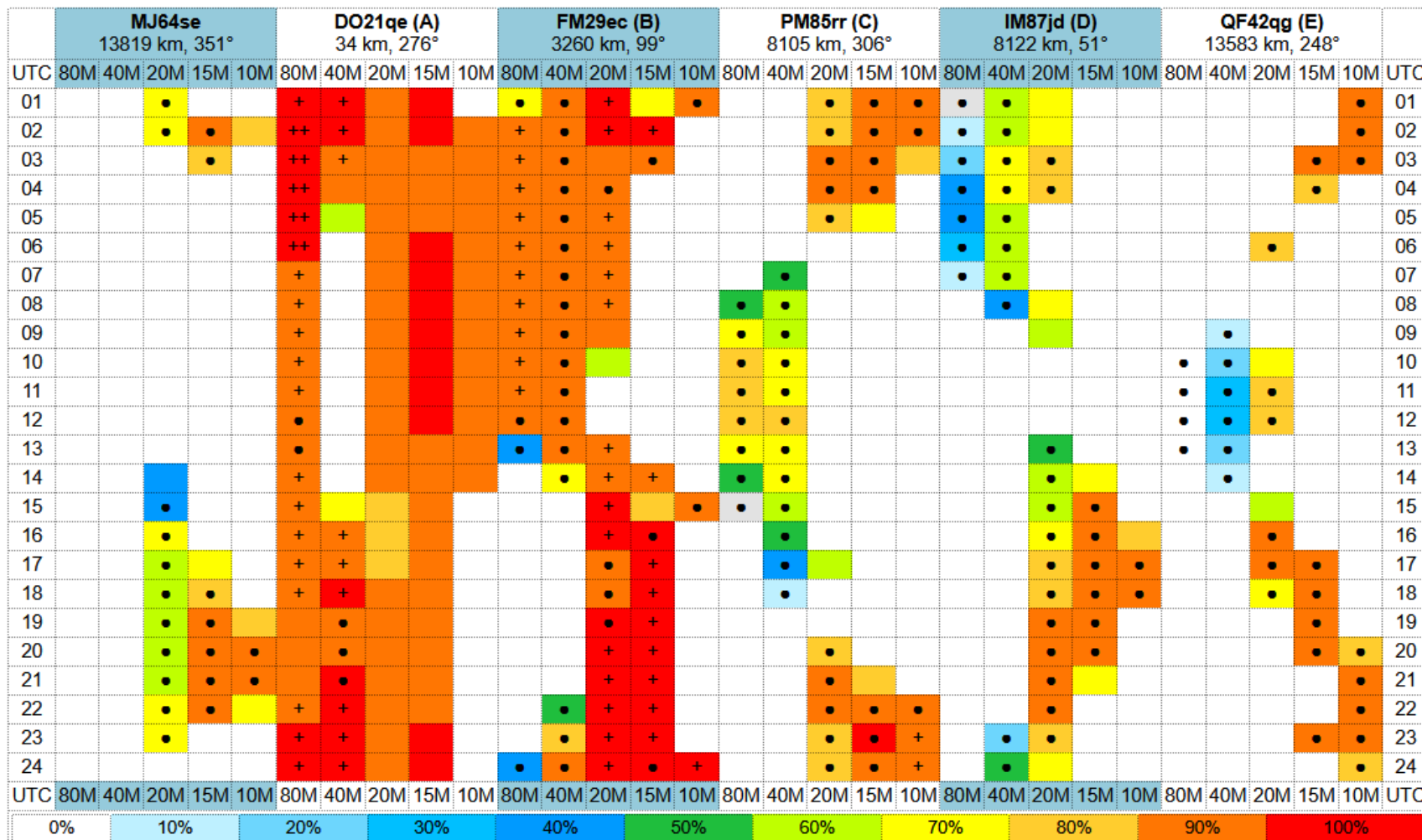
# Competition Planning



Position those five red markers strategically – Most likely competition

# VOACAP Planner DIY

DO21wd (51.15N 114.12W), 2/2025, 0.4000 kW, SSN: 142, REQ.SNR: 13, SHORT-PATH



A= Me, B= US East Coast, C= Southern Europe, D= Japan, E= SE Australia

# SUMMARY

VOACAP can do much more:

- Modeling TOA (Take Off Angle and RX angle)
- Model non-reciprocal paths
- Model different antennas
- Convert reliability of contact to S-meter values
- Grayline modeling
- EME modeling

**Hopefully, this presentation has given you the basics to be able to plan your frequencies and time windows in order to work the countries you need/want. See you in the pileups!**



**THE  
END**