Just About Everything You Need to Know about Propagation – *Briefly*

WØTLM

February 19, 2024

Agenda

- Brief presentation – hopefully
- Panel discussion sharing practical knowledge and experience
- Q&A time

What Do We Mean by Propagation

- “To travel through space or a physical medium.” – dictionary.com
- “The spreading or transmission of something.” – Merriam-Webster
- “The means by which we establish a radio connection between a transmitting and a receiving antenna.” – KEØHz’s definition (claiming no originality)

Radio Waves (Electro-Magnetic Waves)

- The radio wave consists of both an electric and magnetic field oriented 90 degrees from each other
  - That orientation determines the direction the wave travels
- Radio waves travel in a straight line
- But wait – the earth is round!
  - And radio waves travel poorly through the earth
- ***Ground wave propagation*** at HF frequencies is typically limited to a few hundred miles
- Longer distance modes of propagation depend on reflection and refraction

Ground Wave and Sky Waves

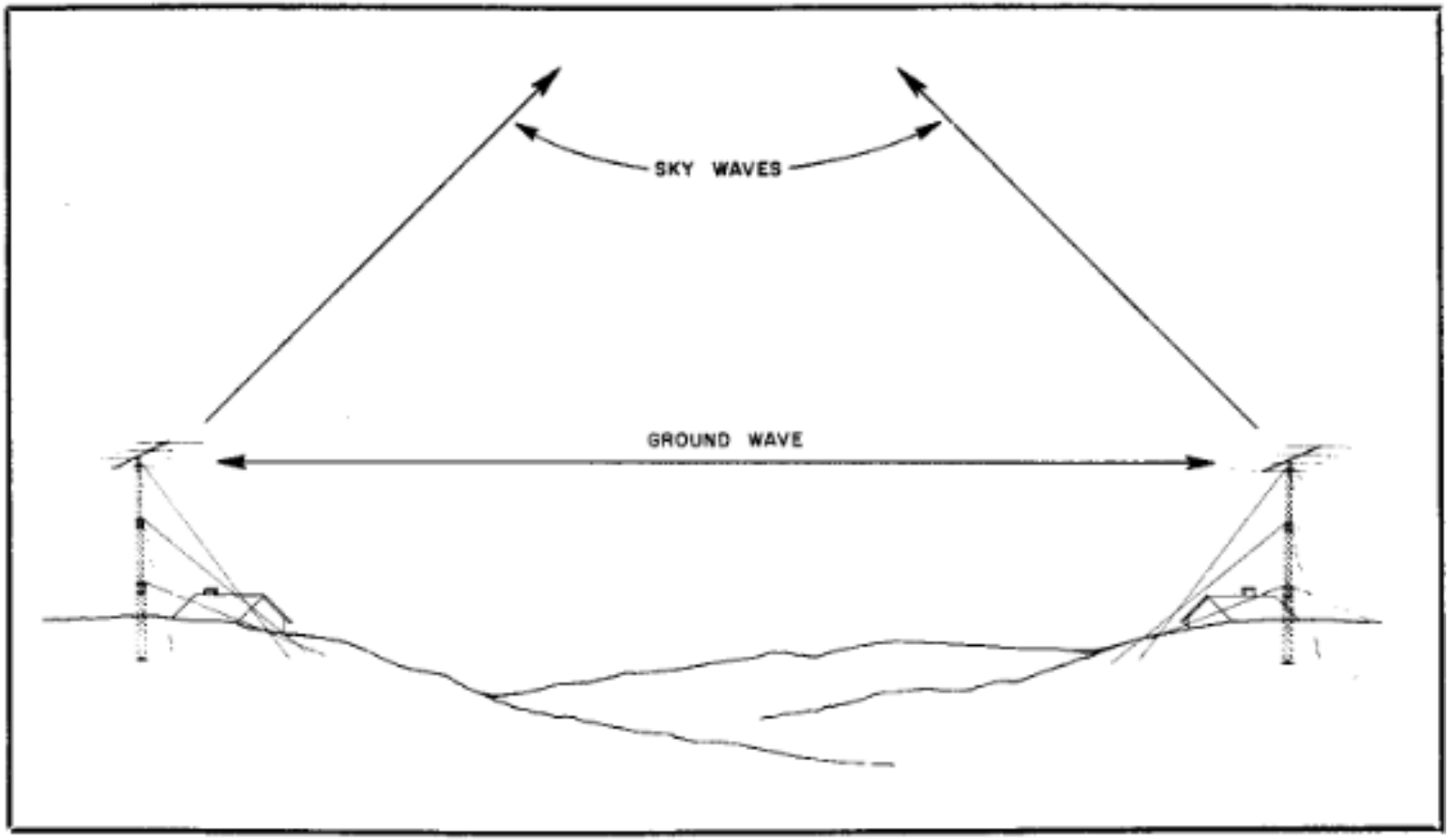


Fig. 1 — An example of the difference between ground waves and sky waves.

QST, December 1983

Sky Wave Refraction

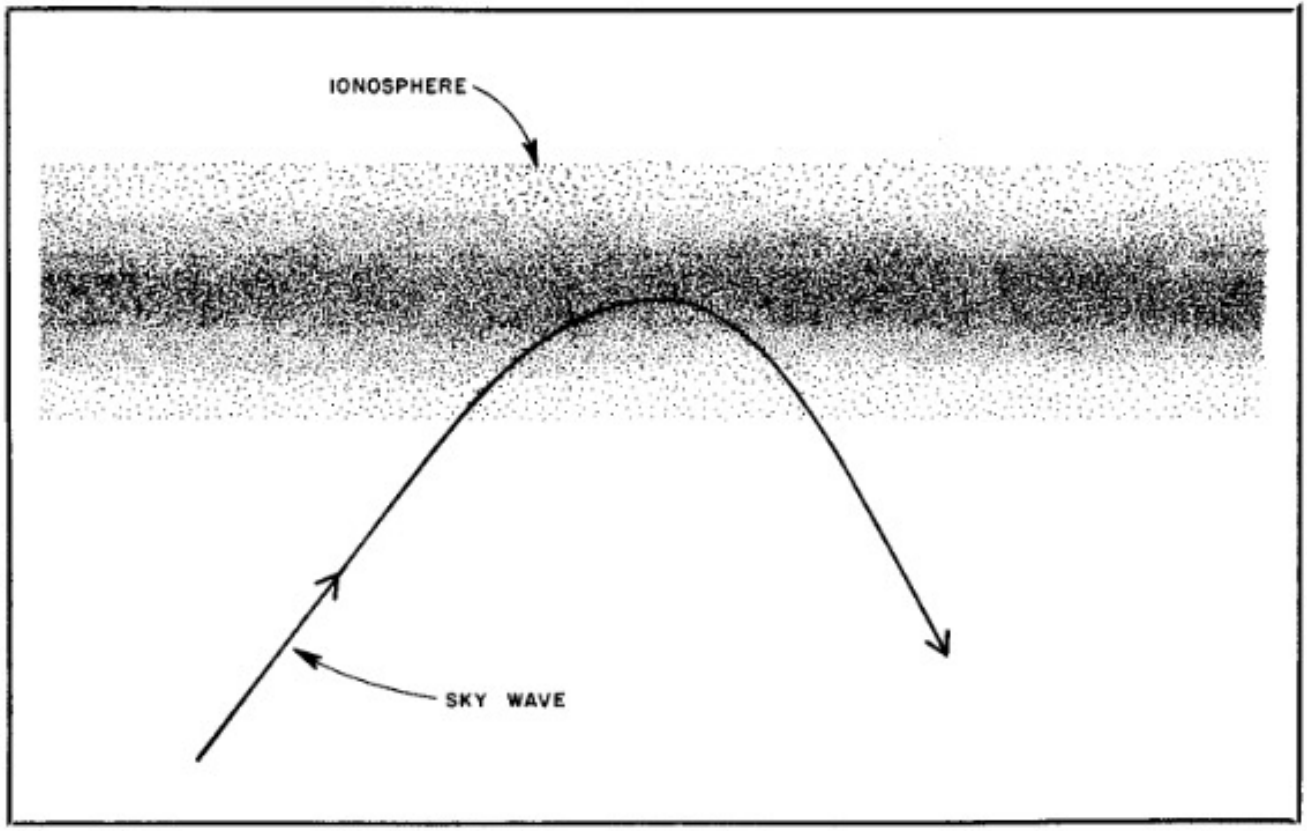


Fig. 2 — Under proper conditions, a radio wave entering the ionosphere will be refracted and follow a new course. This permits the signal to be heard on earth, perhaps thousands of miles from the transmitting antenna.

QST, December 1983

The Ionosphere is a Layer Cake of Charged Particles

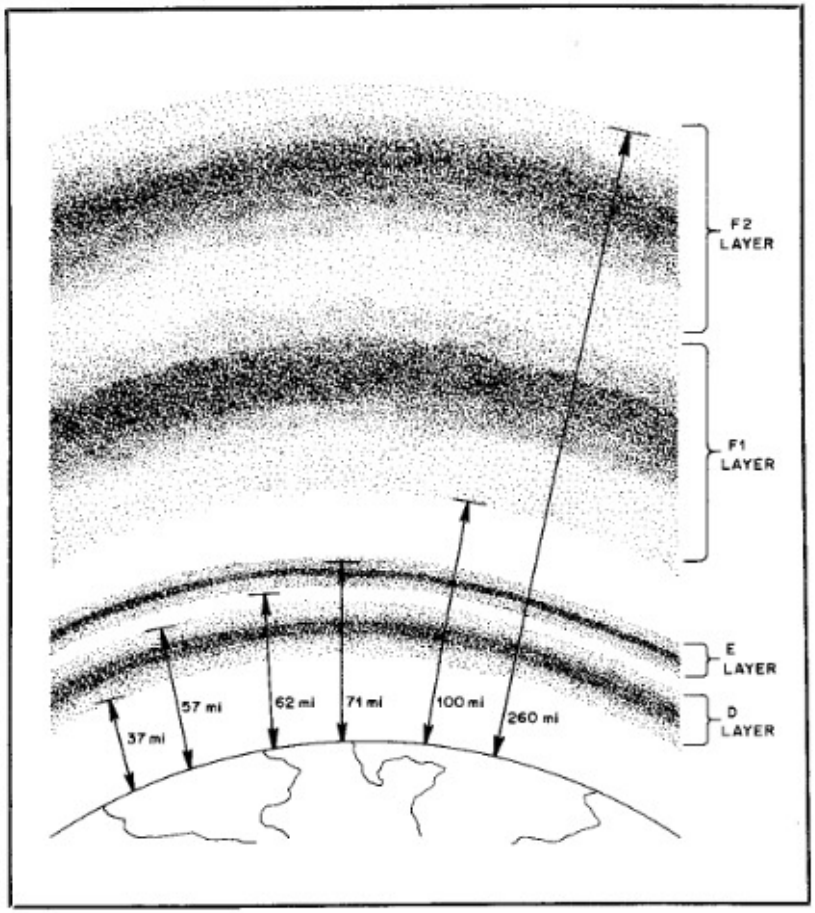


Fig. 3 — The various ionospheric layers with respect to the earth. Distances shown are not absolute, but vary with conditions as explained in the text.

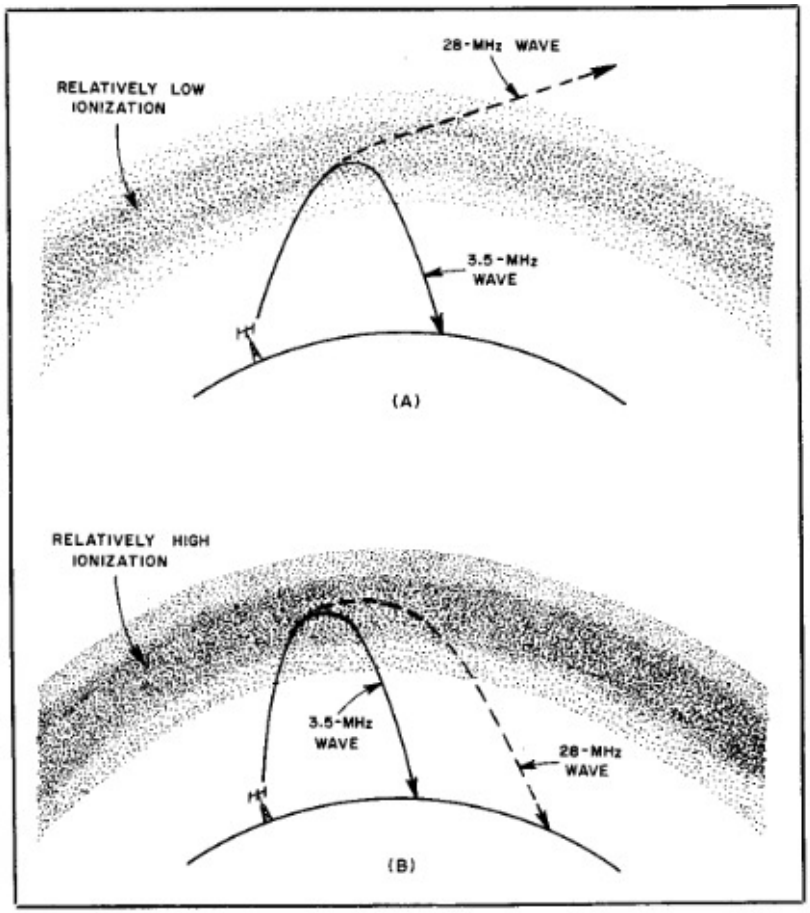
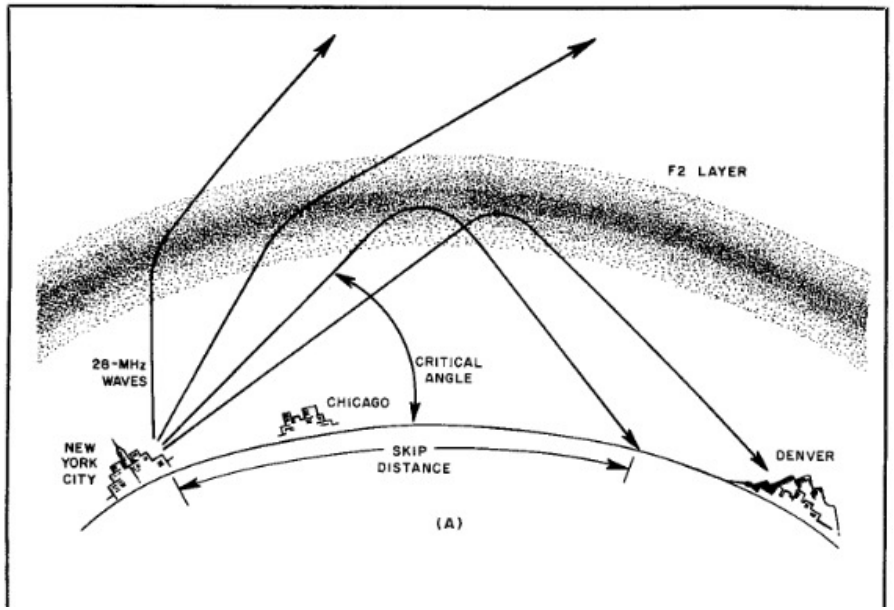


Fig. 5 — In A, the low-level ionization is insufficient to bend the 28-MHz wave back to earth; the level is high enough for 3.5-MHz propagation. Higher-level ionization in B is sufficient to refract the 28-MHz wave to earth.

QST, December 1983

Comparison of 3.5 MHz and 28 MHz Skip



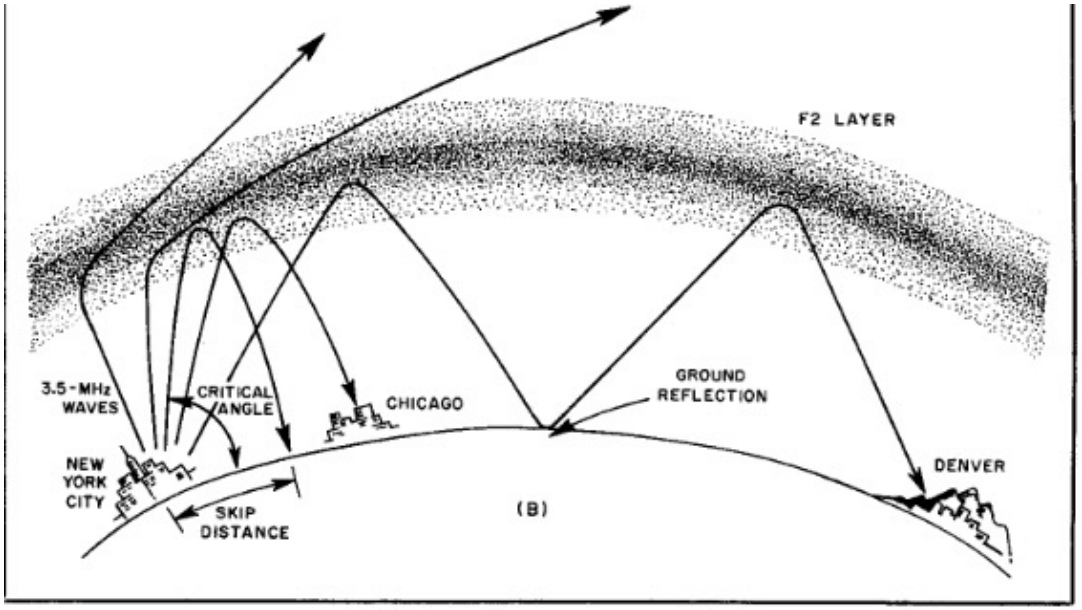


Fig. 6 — Illustration of how frequency, critical angle and skip distance are related. See text for explanation.

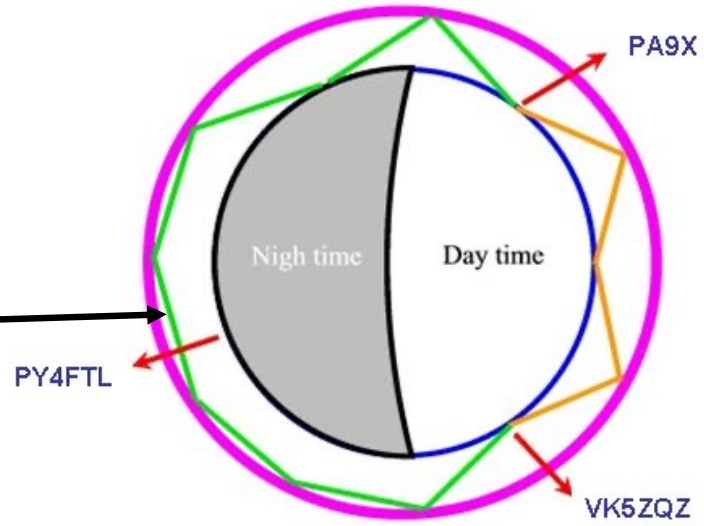
QST, December 1983

Factors That Further Affect Where/How Signal Travels

- Take-off angle from antenna
- Level of solar activity
  - Monitor Solar Flux Index (SFI)
  - Solar storms
  - Lightning (atmospheric noise) can wreak havoc on QSO particularly on 80m and 40m
  - Sudden Ionospheric Disturbances (SIDs)
- Time of day (Diurnal variations)
  - F-layer skip is dependent on UV component of sunlight to ionize the layer.
- Seasons of the year
- Diffractive absorption
- Multipath fading (think noise-cancelling headphones)

Other Propagation Modes

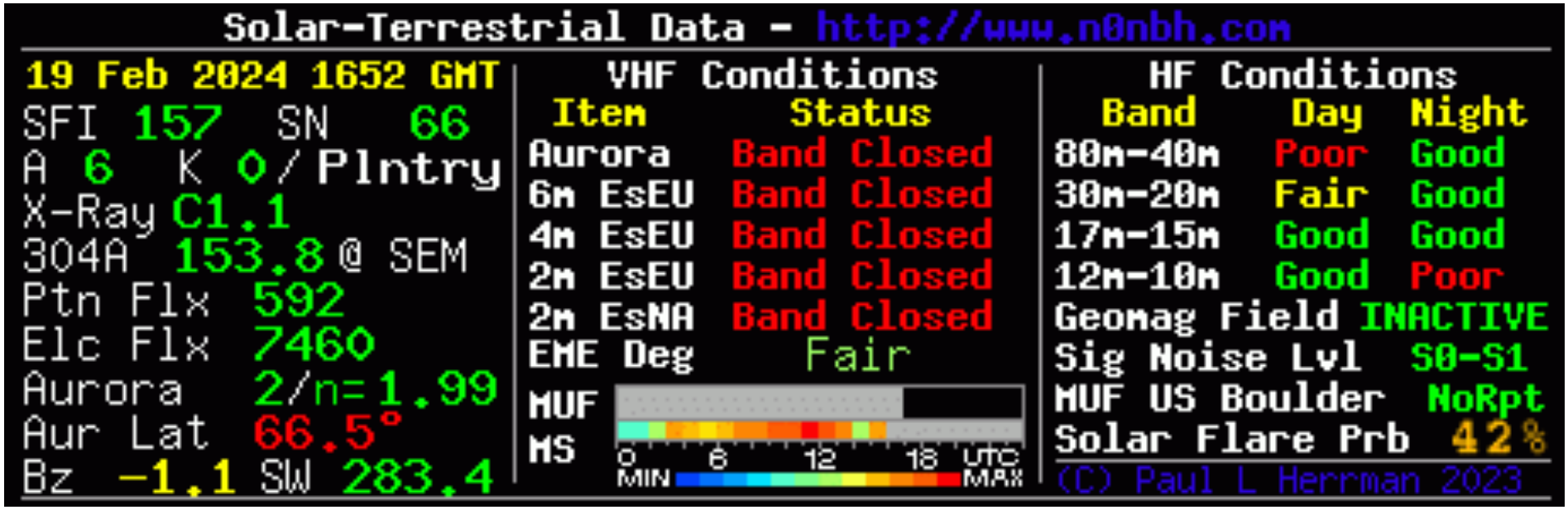
- Tropospheric
- Scatter
- Sporadic E
- Gray-Line
- Chordal Hop



https://www.pa9x.com/long-path-or-short-path-propagation/

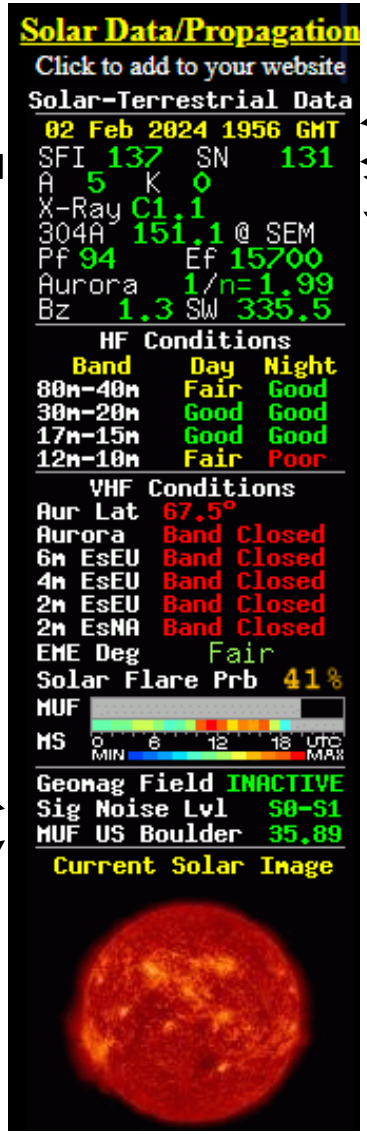
Solar Data

Paul L Herrman
Sierra Vista, Arizona USA (DM41um)
Solar Data Banners & Widgets
UTC: Mon 19 Feb 2024 - 16:56:04
n0nbh@n0nbh.com



Practical Uses of Propagation Predictions

I check the overall propagation before I get on the air. I use N0NBH's website: HamQSL.com. However, it can be wrong, so I may try a band that looks bad or closed before giving up.



Date/Time

Solar Flux Index (SFI)

Sunspot Number (SN)

Geomagnetic Storms (K Index)

Band Conditions

Signal to Noise level

Maximum Usable Frequency (Boulder CO)

This alert is emailed to me daily.

```
:Product: NOAA 3-day Geomagnetic Forecasts
:Issued: 2024 Feb 02 2200 UTC
# Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center
#
NOAA Ap Index Forecast
Observed Ap 01 Feb 005
Estimated Ap 02 Feb 004
Predicted Ap 03 Feb-05 Feb 005-014-020

NOAA Geomagnetic Activity Probabilities 03 Feb-05 Feb
Active                15/35/25
Minor storm           01/25/40
Moderate storm        01/05/15
Strong-Extreme storm  01/01/01

NOAA Kp index forecast 03 Feb - 05 Feb
             Feb 03    Feb 04    Feb 05
00-03UT        1.67      2.00      5.00
03-06UT        1.33      2.00      3.67
06-09UT        1.33      2.33      3.67
09-12UT        1.33      1.67      3.33
12-15UT        1.33      2.00      3.00
15-18UT        1.33      3.33      2.33
18-21UT        1.67      4.00      2.33
21-00UT        1.67      4.33      3.00
```

Space Weather Message Code: ALTXMF
Serial Number: 337
Issue Time: 2024 Jan 29 0428 UTC

ALERT: X-Ray Flux exceeded M5
Threshold Reached: 2024 Jan 29 0427 UTC
NOAA Scale: R2 - Moderate

NOAA Space Weather Scale descriptions can be found at
www.swpc.noaa.gov/noaa-scales-explanation

SPACE WEATHER ADVISORY OUTLOOK #24-6
2024 February 4 at 5:19 p.m. MST (2024 February 5 0019 UTC)

**** SPACE WEATHER OUTLOOK ****

Summary For January 29-February 4

R1 (Minor) radio blackouts were observed on 29 Jan, 02 Feb and 04 Feb.

S1 (Minor) radiation storms were observed on 29-30 Jan.

No other significant space weather was observed.

Outlook For February 5-11

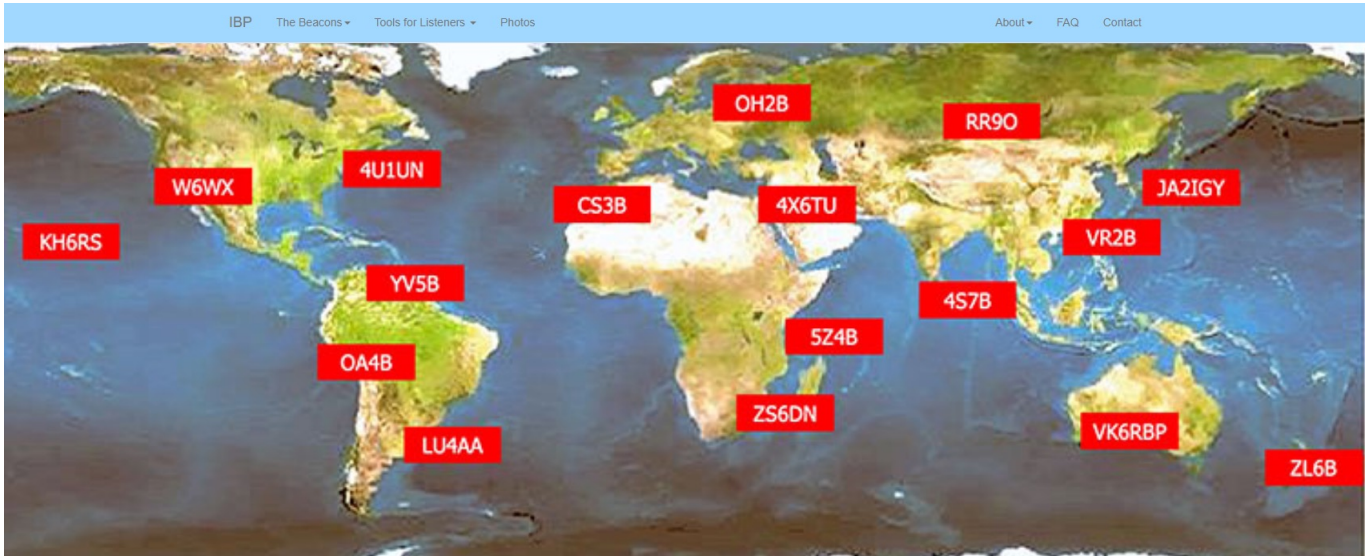
G1 (Minor) geomagnetic storms are expected on 05 Feb.

R1-R2 (Minor-Moderate) radio blackouts are likely on 05-11 Feb.

No ther significant space weather is expected.

Data used to provide space weather services are contributed by NOAA, USAF, NASA, NSF, USGS, the International Space Environment Services and other observatories, universities, and institutions. More information is available at SWPC's Web site http://swpc.noaa.gov

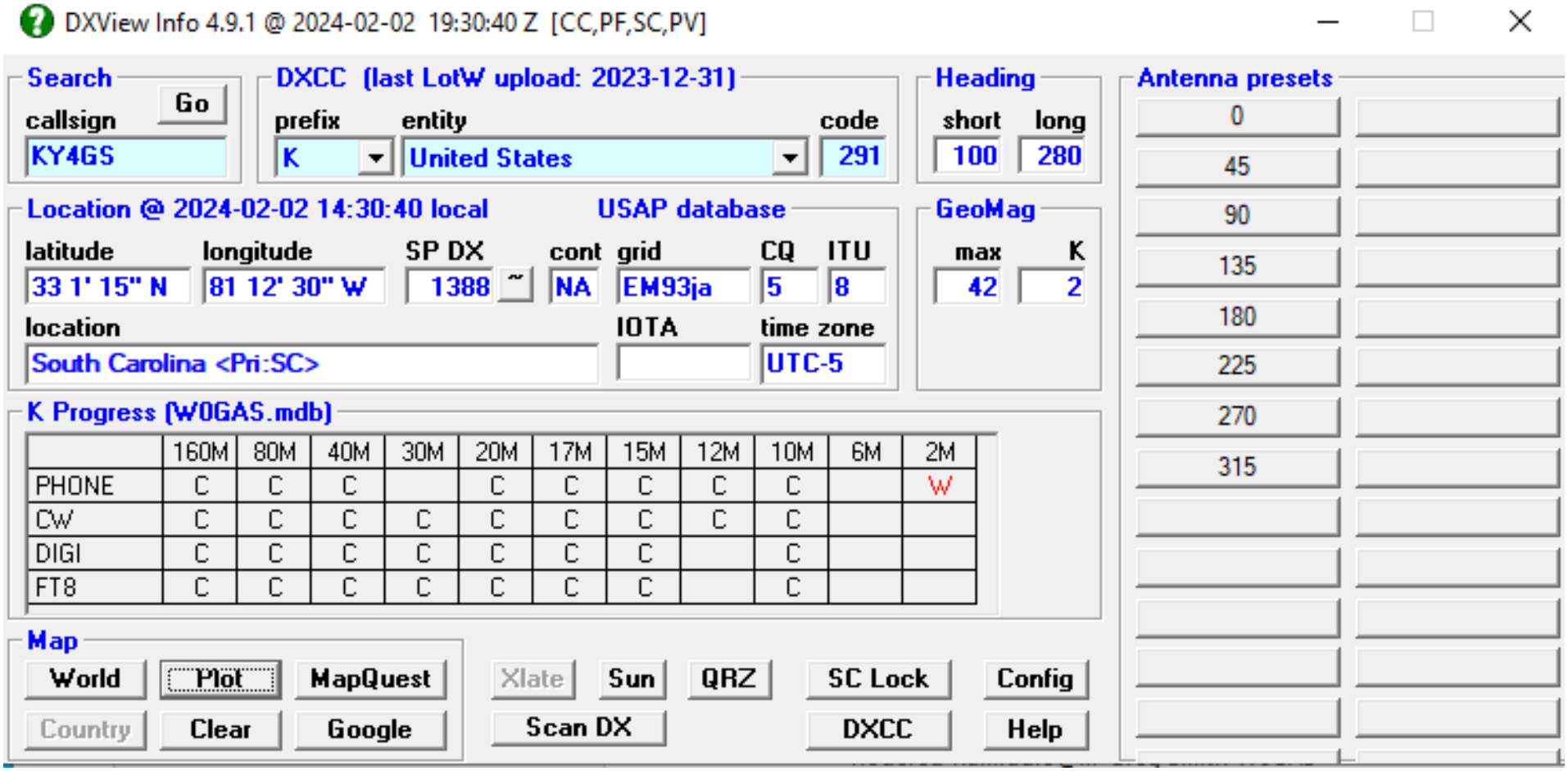
NCDXF/IARU International Beacon Project



Each beacon transmits once on each band once every three minutes, 24 hours a day.
A transmission consists of the callsign of the beacon sent at 22 words per minute followed by four one-second dashes.
The callsign and the first dash are sent at 100 watts. The remaining dashes are sent at 10 watts, 1 watt and 100 milliwatts.
At the end of each 10 second transmission, the beacon steps to the next higher band and the next beacon in the sequence begins transmitting.

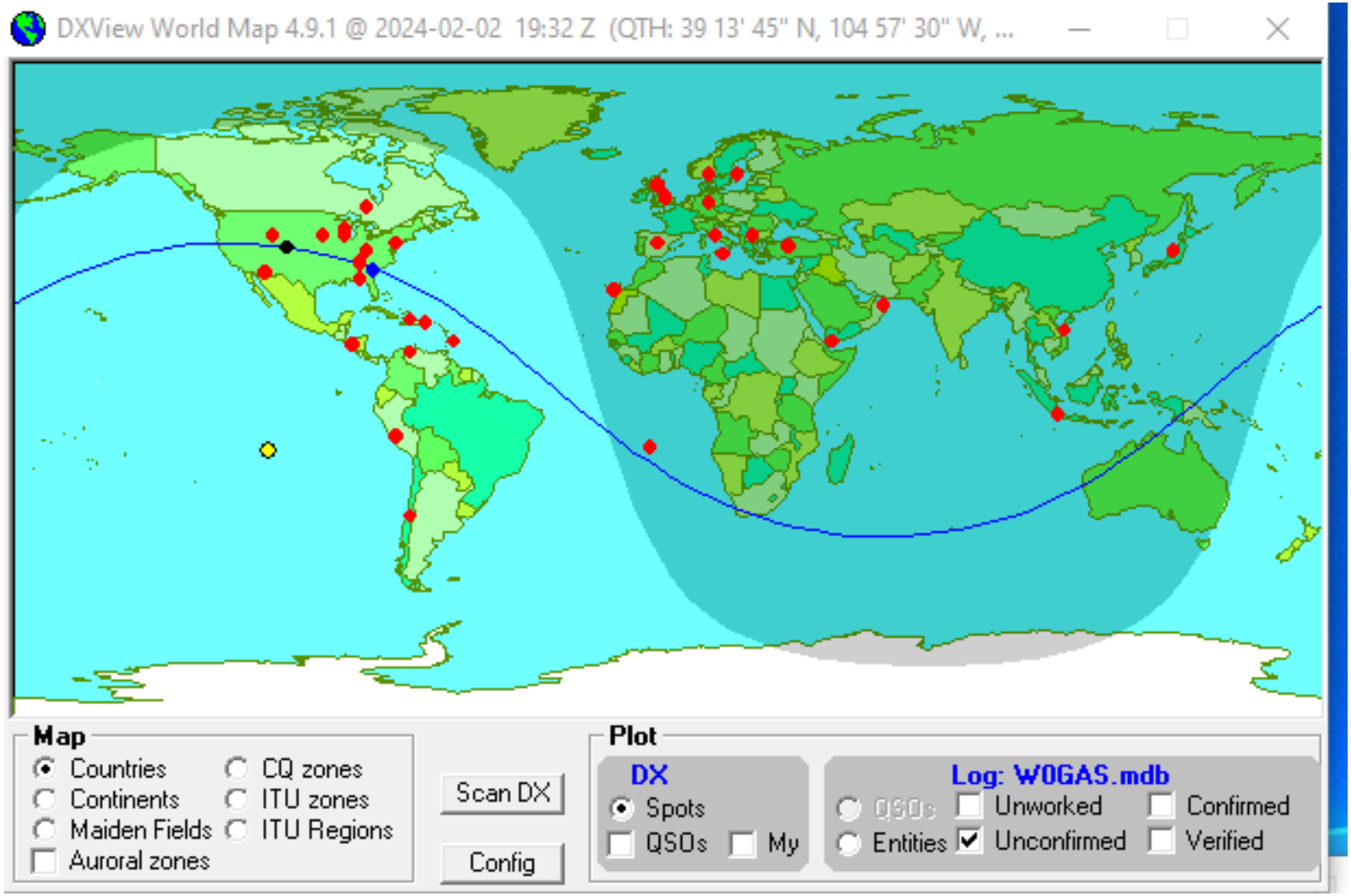
How to Predict Propagation for a Sked

- This example uses DXView and PropView, both of which are included in the free suite of loggin programs offered by DX Labs.
- The same thing can be done on-line for free using VOACAP

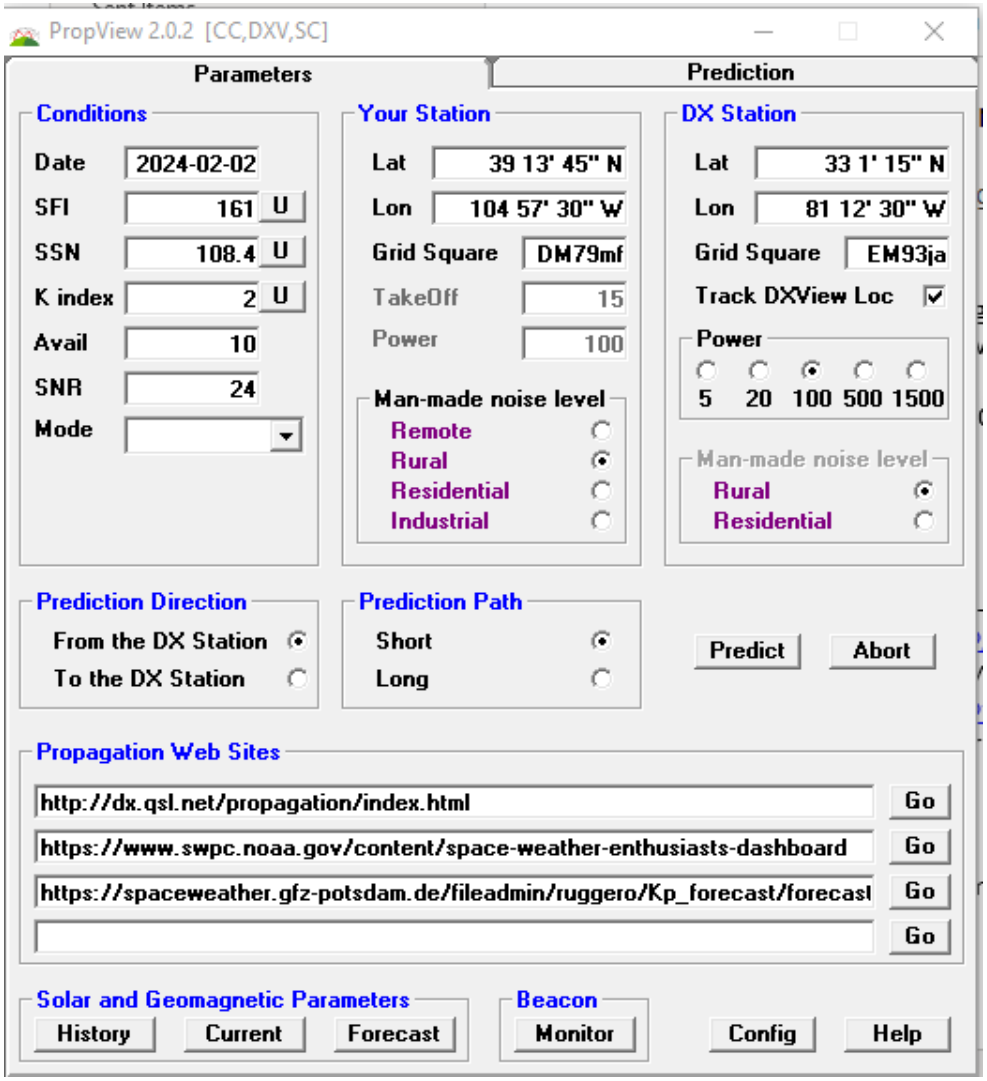


I use my logging suite from DX Labs to figure out how to have a sked. I insert the call of the station I want to work and hit go. The rest is filled in by DX View. This is for KY4GS. Amanda is in South Carolina.

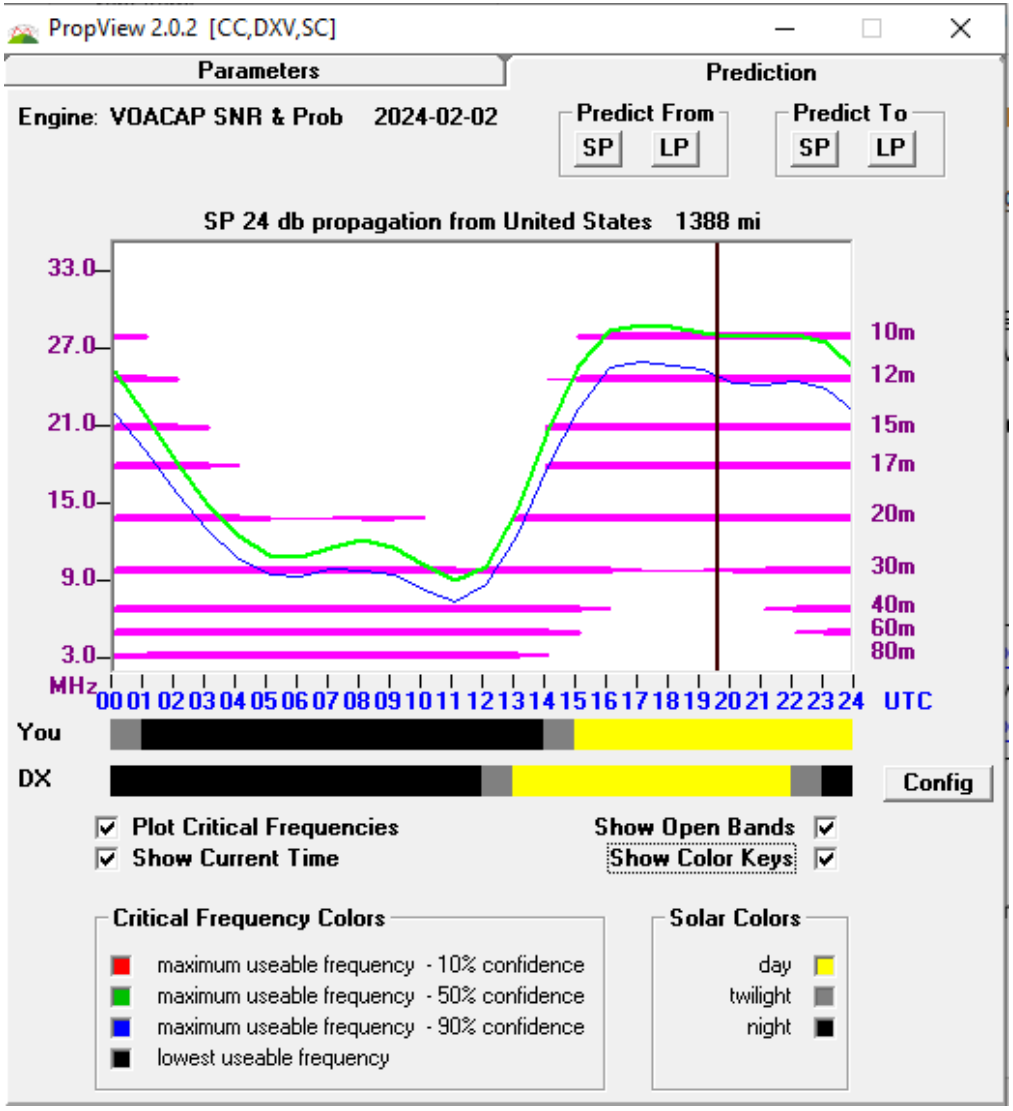
DXView plots the short and long path to the other station. Mine is in black (Denver) and hers is in blue (SC).



PropView is also part of the DXLabs suite. It auto completes from the panel where I put in the other station's call. Note that it shows current data like SFI (Solar Flux Index) and SSN (Sun Spot Number). Note I can toggle the direction and the path (SP or LP)



PropView also shows the times and MUF's (90% and 50% confidence) for the short path to KY4GS. Once again, note the toggles (direction and path).



How to Plan to Work a DX Station

- How do you pick stations that are on the air
- How do you plan the times and bands when your odds of catching that DX are best?

Subscribe to the ARRL DX News

This week's bulletin was made possible with information provided by The Daily DX, 425 DX News, DXNL, Contest Corral from QST and the ARRL Contest Calendar and WA7BNM web sites. Thanks to all.

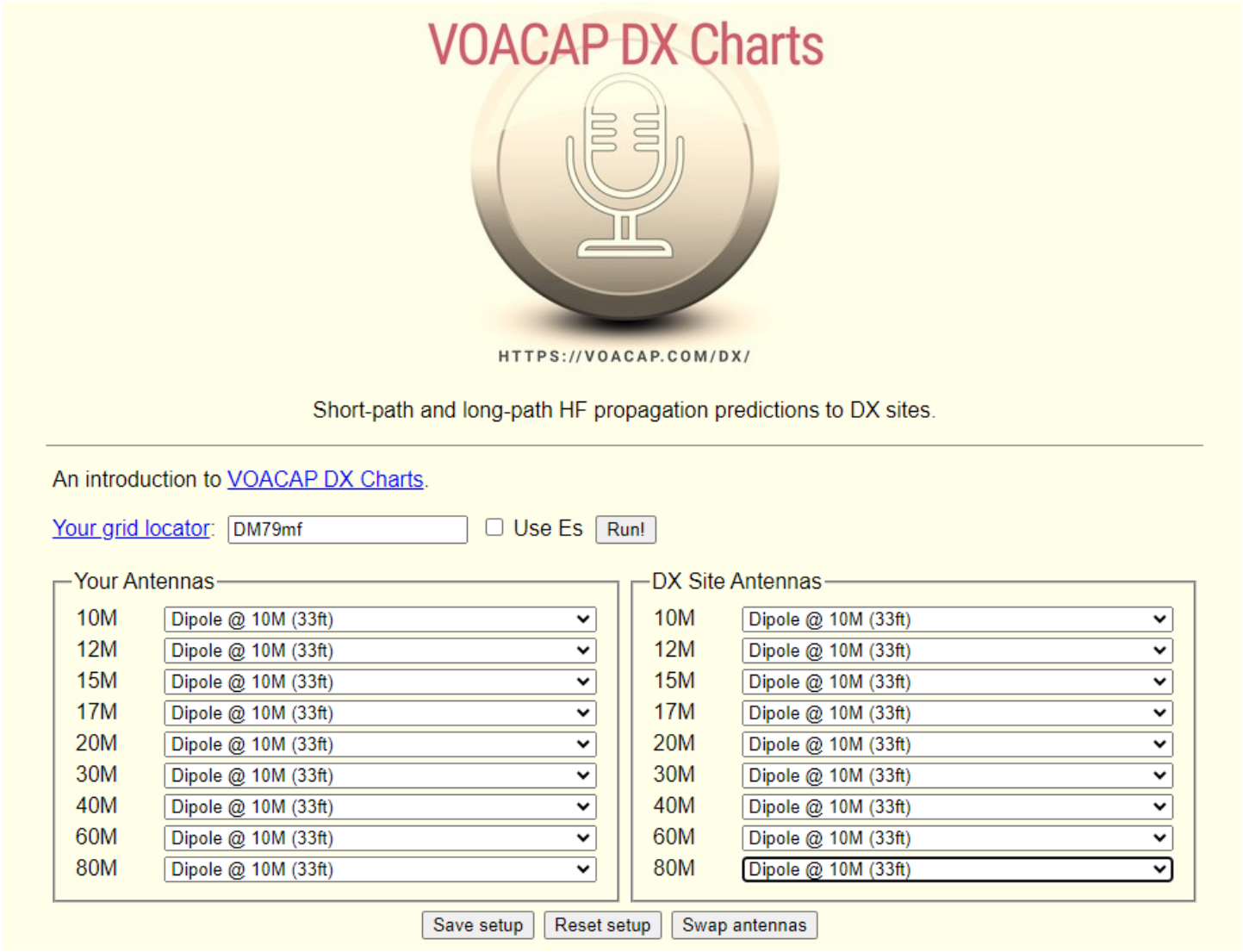
GEORGIA, 4L. Look for 4L9M, and 4L7ZS to each be active in the CQ World Wide 160 Meter CW contest.
QSL 4L9M direct and 4L7ZS via LoTW.

SENEGAL, 6W. Gerhard, OE3GEA plans to be QRV as 6W/OE3GEA near Dakar from January 27 to February 4. Activity will be on 30 to 10 meters using CW. QSL to home call.

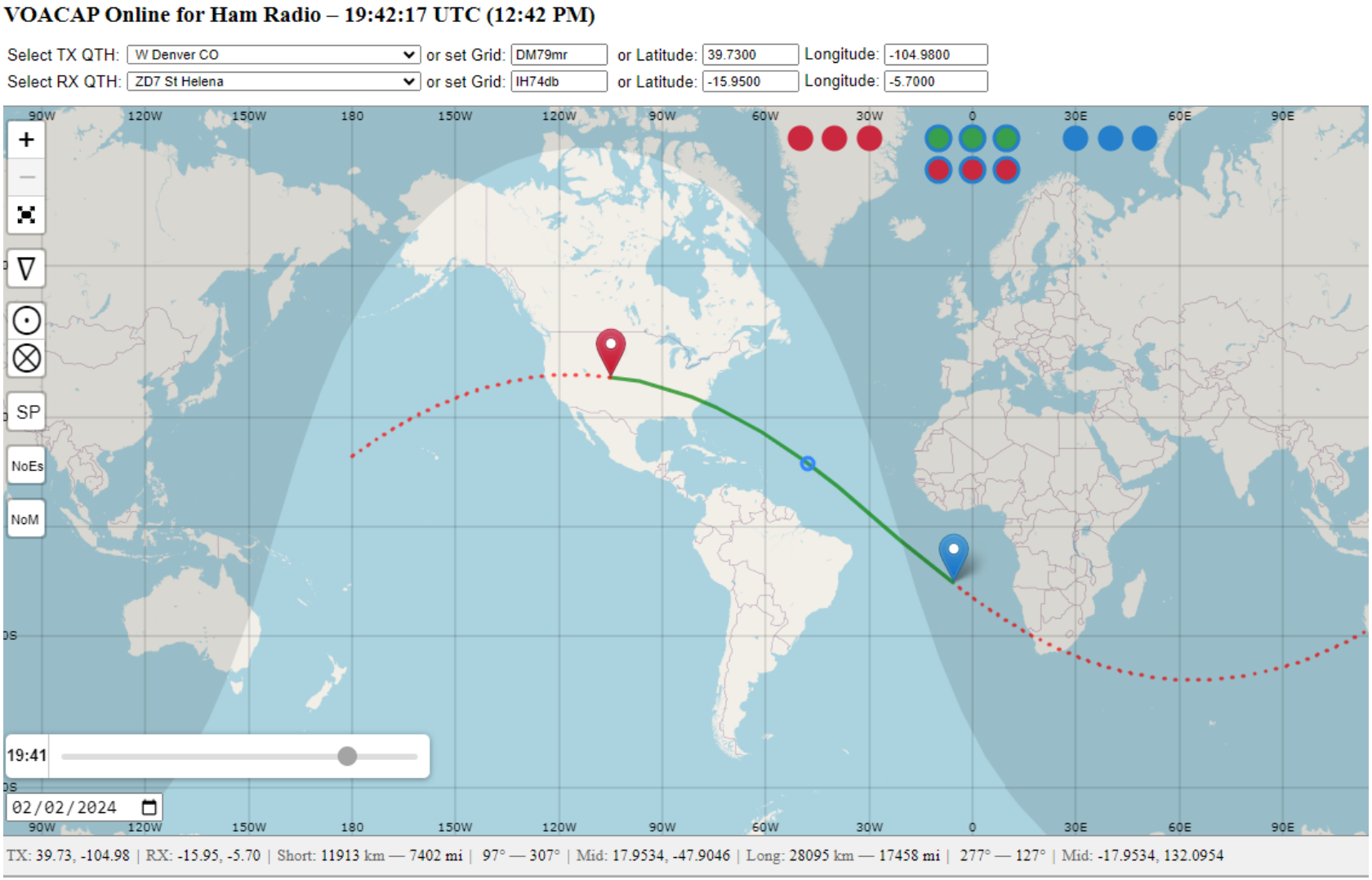
YEMEN, 7O. Vlad, OK2WX is QRV as 7O2WX from Socotra Island, IOTA AF-028, until February 12. Activity is on 160, 80, and 40 meters.
This includes an entry in the CQ World Wide 160 Meter CW contest.
QSL via IZ8CCW.

MALDIVES, 8Q. Keith, G3WRO is QRV as 8Q7WR until February 6.
Activity is holiday style on 40 to 10 meters, and possibly on 80 meters, using SSB. QSL to home call.

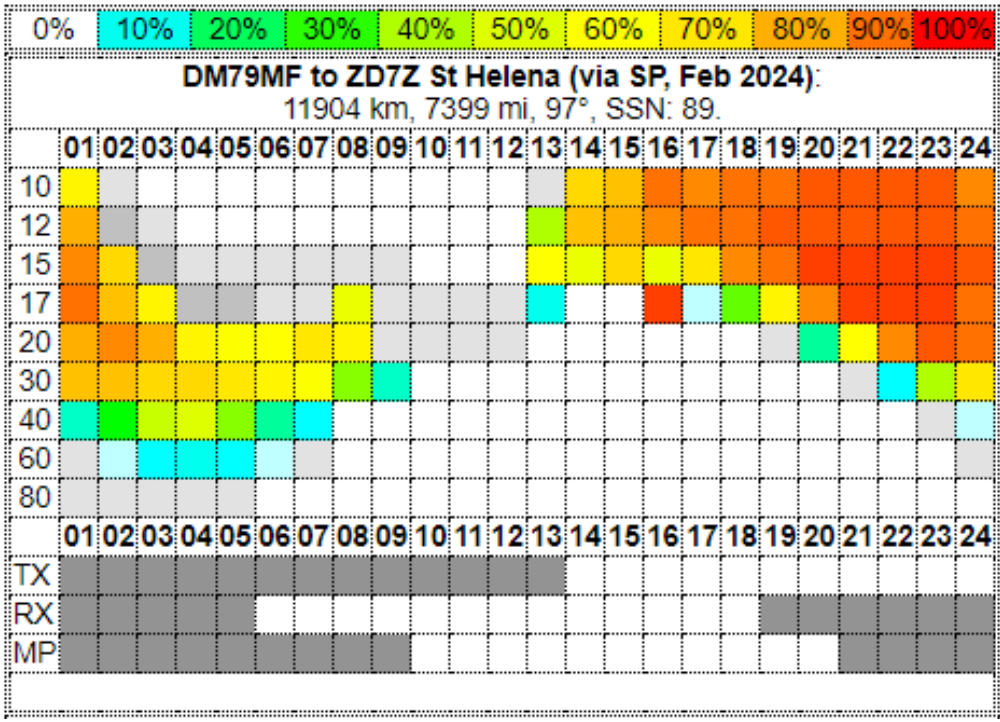
What if you don't have DXLabs for your logging? Then go to the free VOACAP website. This is set up for me. I have an EFHW, but use the dipole since it is closest to an EFHW.

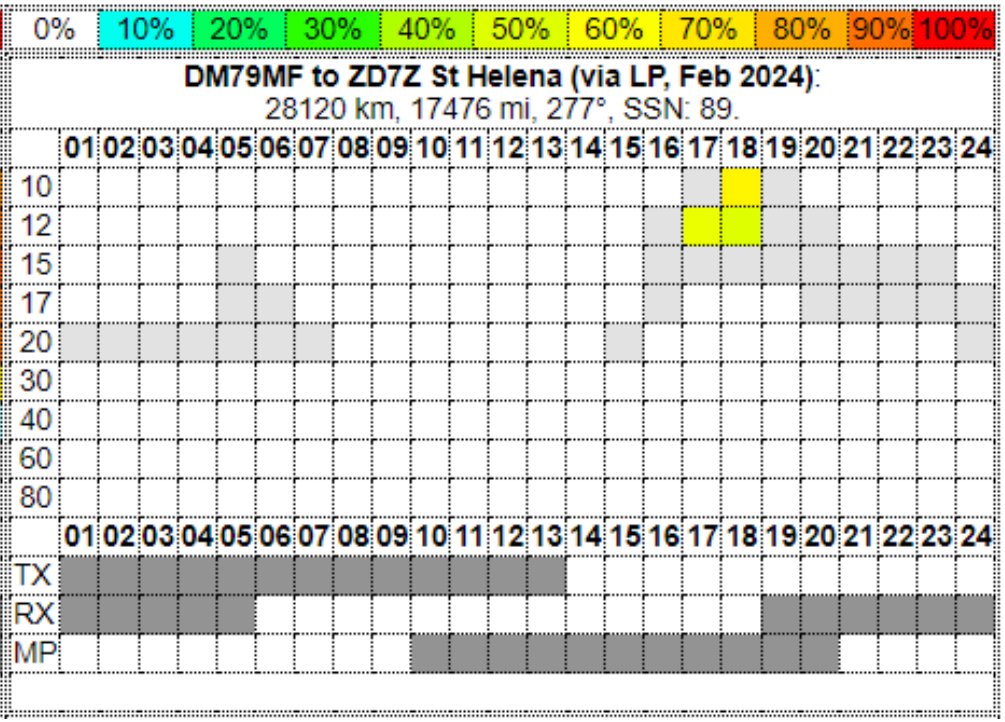


See the short path to St. Helena Island? Red is Denver, Blue is St. Helena



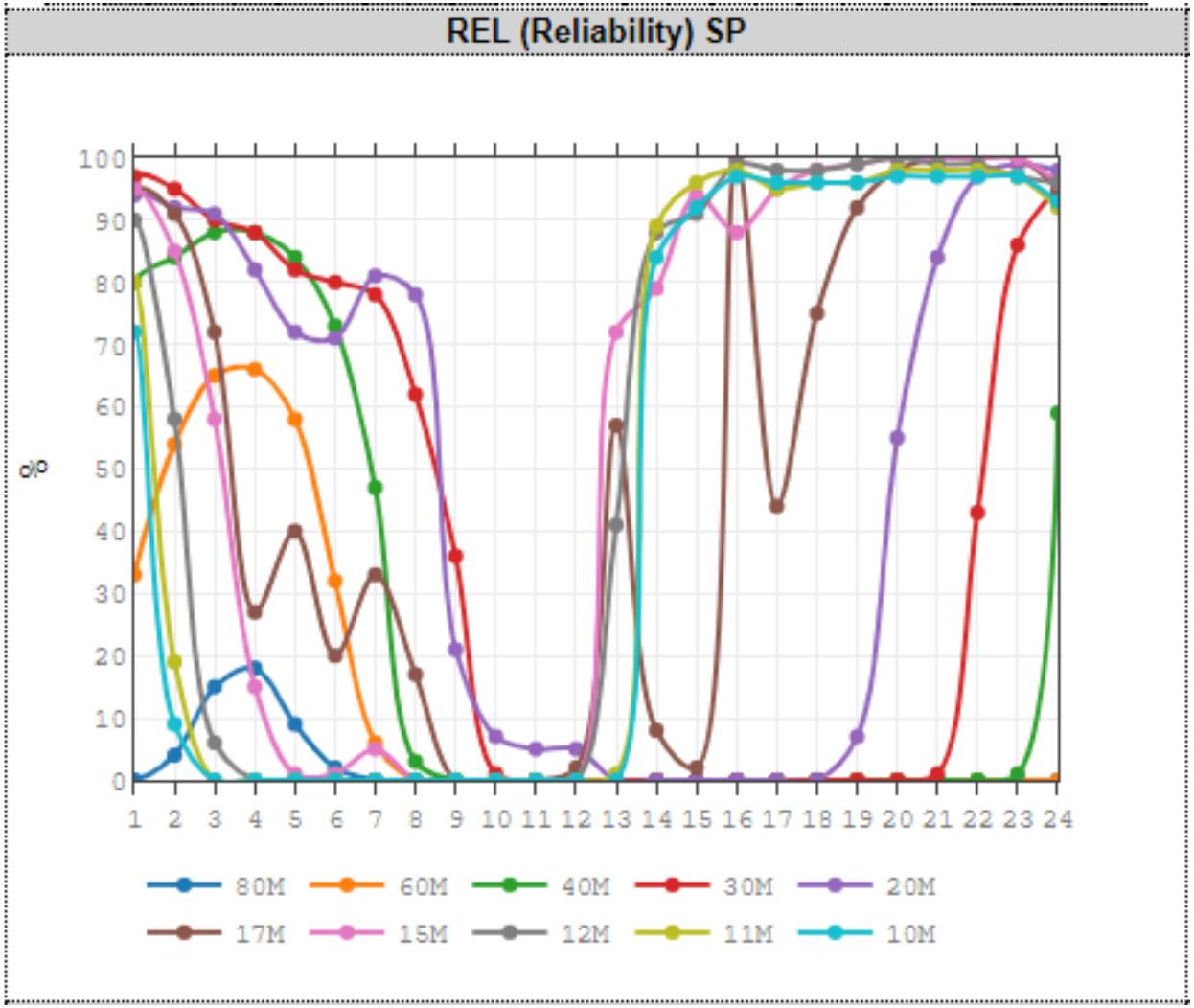
VOACAP DX Charts





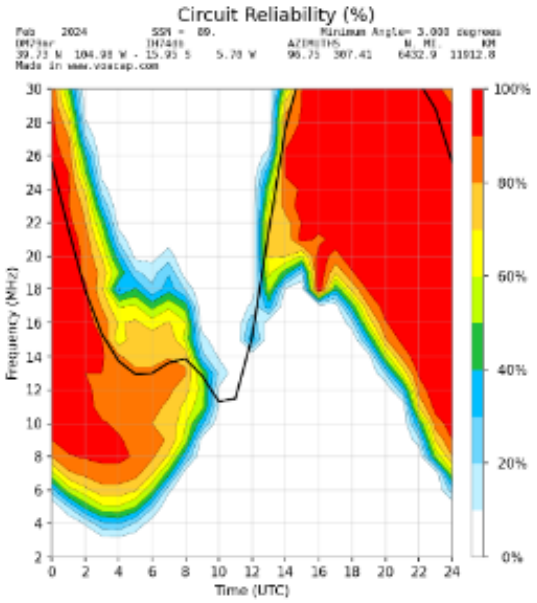
These charts show the SP and LP propagation. Color shows probability, vertical scale shows bands, horizontal scale shows time (UTC). Once again, this shows propagation from my shack to ZD7Z. You will want to flip the input to see how well ZD7Z can transmit to me – for the full picture. Always uses UTC time.

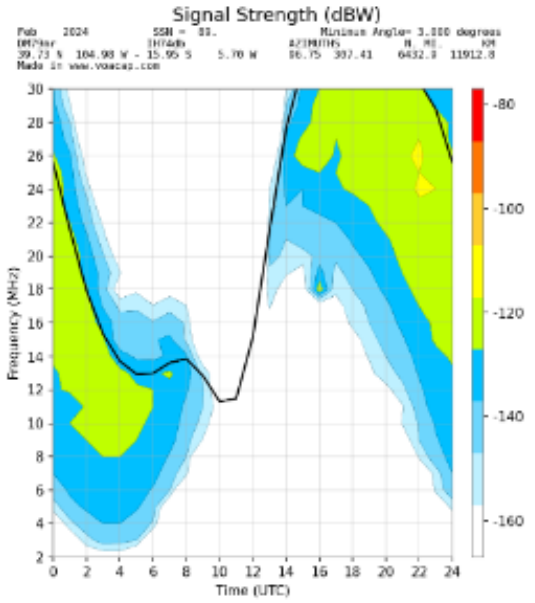
VOACAP generates lots of data. This shows reliability (vertical scale), band by band (colored lines), hour by hour (horizontal scale) from my shack to ZD7Z.

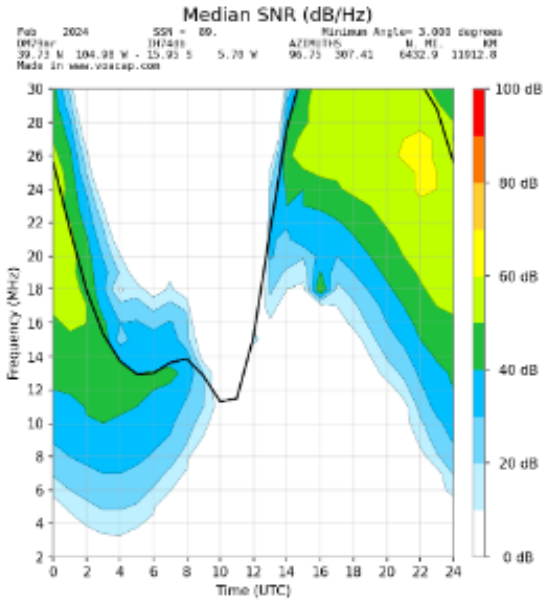


VOACAP Online for Ham Radio - Google Chrome

voacap.com/hf/rel_sdbw.html







These show circuit reliability, signal strength, and median SNR (signal to noise ratio) from my QTH to ZD7Z