No-cost Software for Portable DXing:
— Digital Modes
— Propagation Prediction

— Plan before you go!

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2018 April 3
to: BRARA

Hardware and Software Make the Difference

- A basic radio supports Morse, Phone
- Add a small computer and DAC/sound card to evolve into a Basic SDR System
  - software supports digital modes
  - includes high-sensitivity weak signals modes
- When to use your Basic SDR System:
  - software for HF propagation planning

Building the Basic SDR

- “A Software-Defined Radio (SDR) System is a radio communication system which uses software for the *modulation* and *demodulation* of radio signals” [2004]*

* https://web.archive.org/web/20040329020313/https://en.wikipedia.org/wiki/Software-defined_radio

Adding Basic SDR Capability

- "A Software-Defined Radio (SDR) system is a radio communication system which uses software for the *modulation* and *demodulation* of radio signals" [2004]*
- "A basic SDR system may consist of a personal computer equipped with a sound card, or other analog-to-digital converter, preceded by some form of RF front end [2009]*
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Adding Basic SDR Capability

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- "A basic SDR system may consist of a personal computer equipped with a sound card, or other analog-to-digital converter, preceded by some form of RF front end [2009]*
- … Such a design produces a radio which can receive and transmit widely different radio protocols (sometimes referred to as waveforms) based solely on the software used" [2018]*

* https://en.wikipedia.org/wiki/Software-defined_radio

A Basic SDR System: plug and play

Computer and Software:
Adds "software defined radio" capability

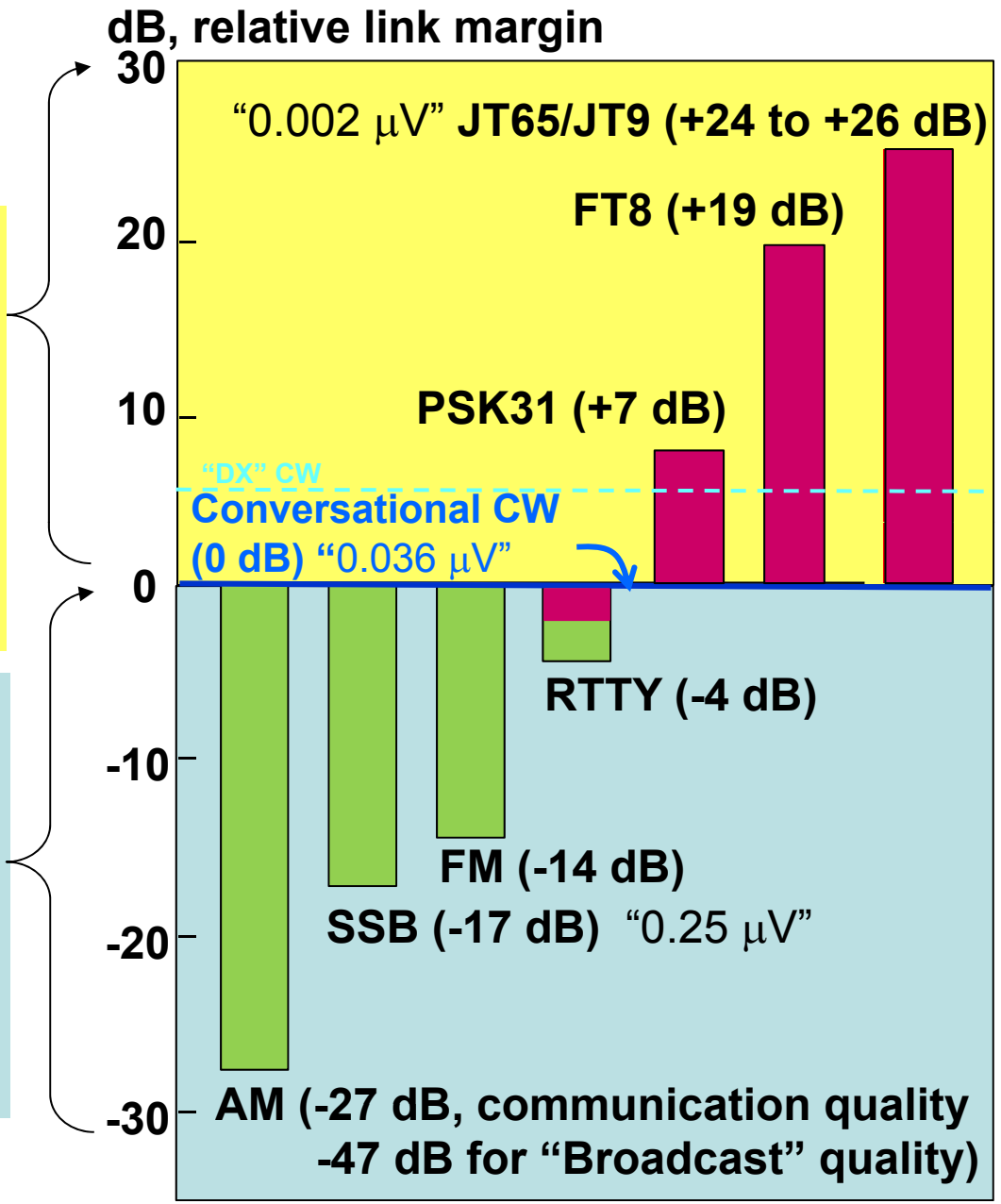
SignaLink-USB:
D⇔A interface sound card with PTT

Radio:
Upper Digi/SSB for all digi-modes, last IF: 300 — 2800 Hz

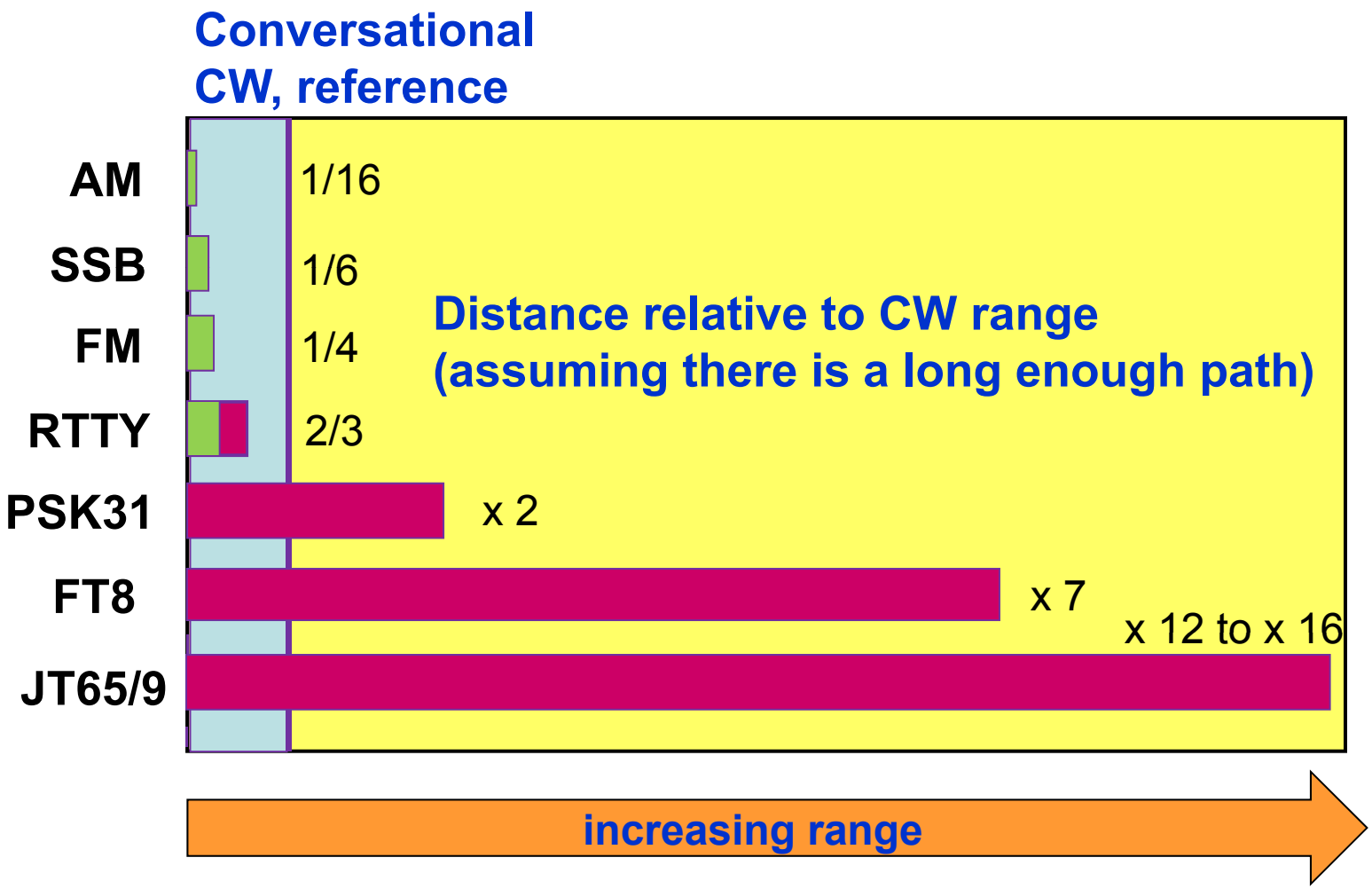
Why SDR?

- Basic SDR System supports Software Defined Modulation: can turn “0.25 μV” into “0.002 μV”

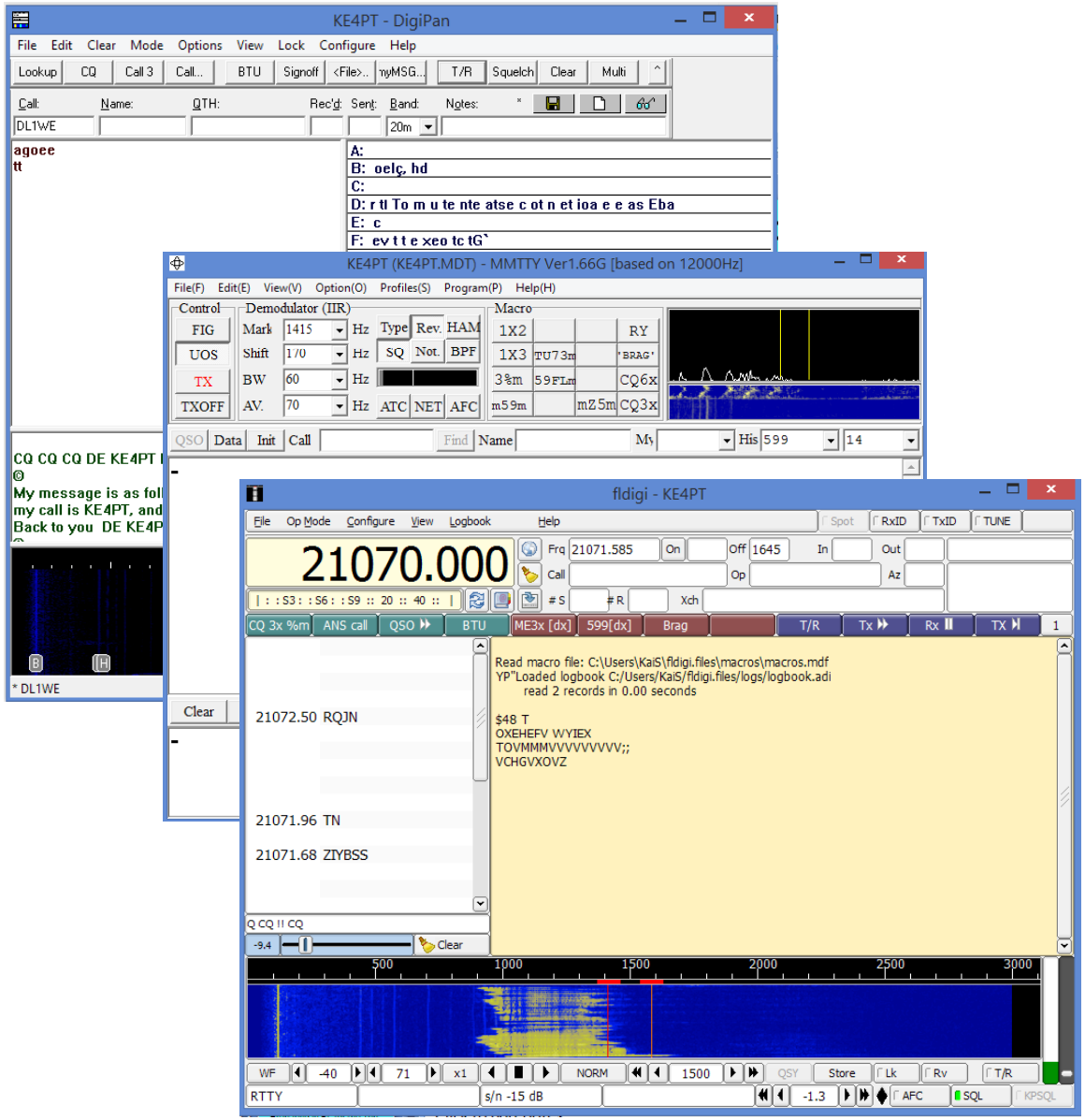
- Basic Radio has native support for Morse CW, voice and *sometimes* RTTY



What the SDR System Buys You

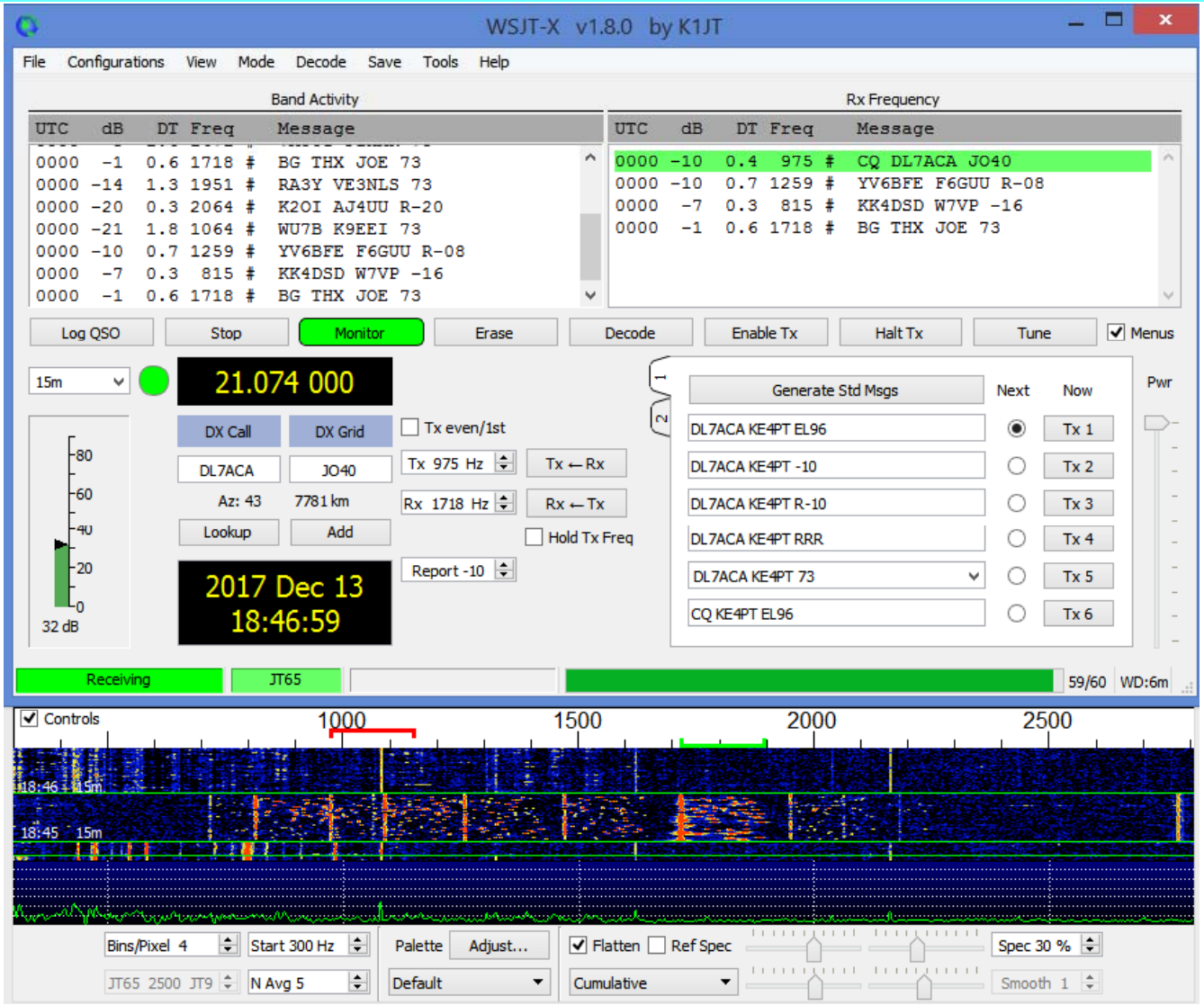


Free Digital Modulation Software



- **Digipan** for PSK (only)
- **MMTTY** for RTTY (only)
- **FLDIGI** for *dozens* of digital modes, including PSK and RTTY
- More *free* software being produced!

WSJT-X Weak Signal Modes



- ***WSJT-X*** supports **JT9, JT65, FT8** modes + more
- <u>The Payoff</u>: Can add up **to 26 dB** of link margin *vs.* CW
- See: "WSJT-X Modes", *QST*, Oct and Nov 2017

The *WSJT-X* Modes

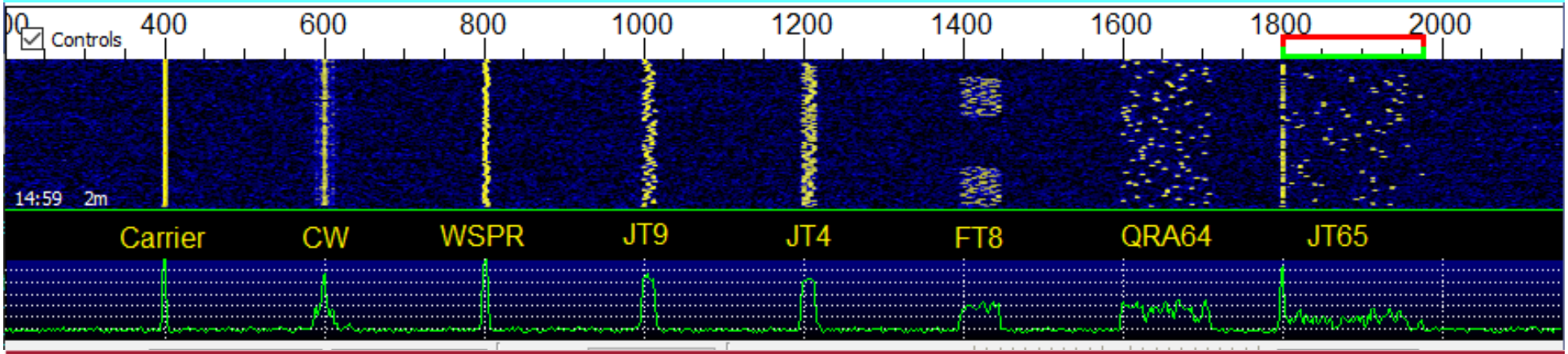


Table 1: Parameters of the Slow *WSJT-X* Protocols

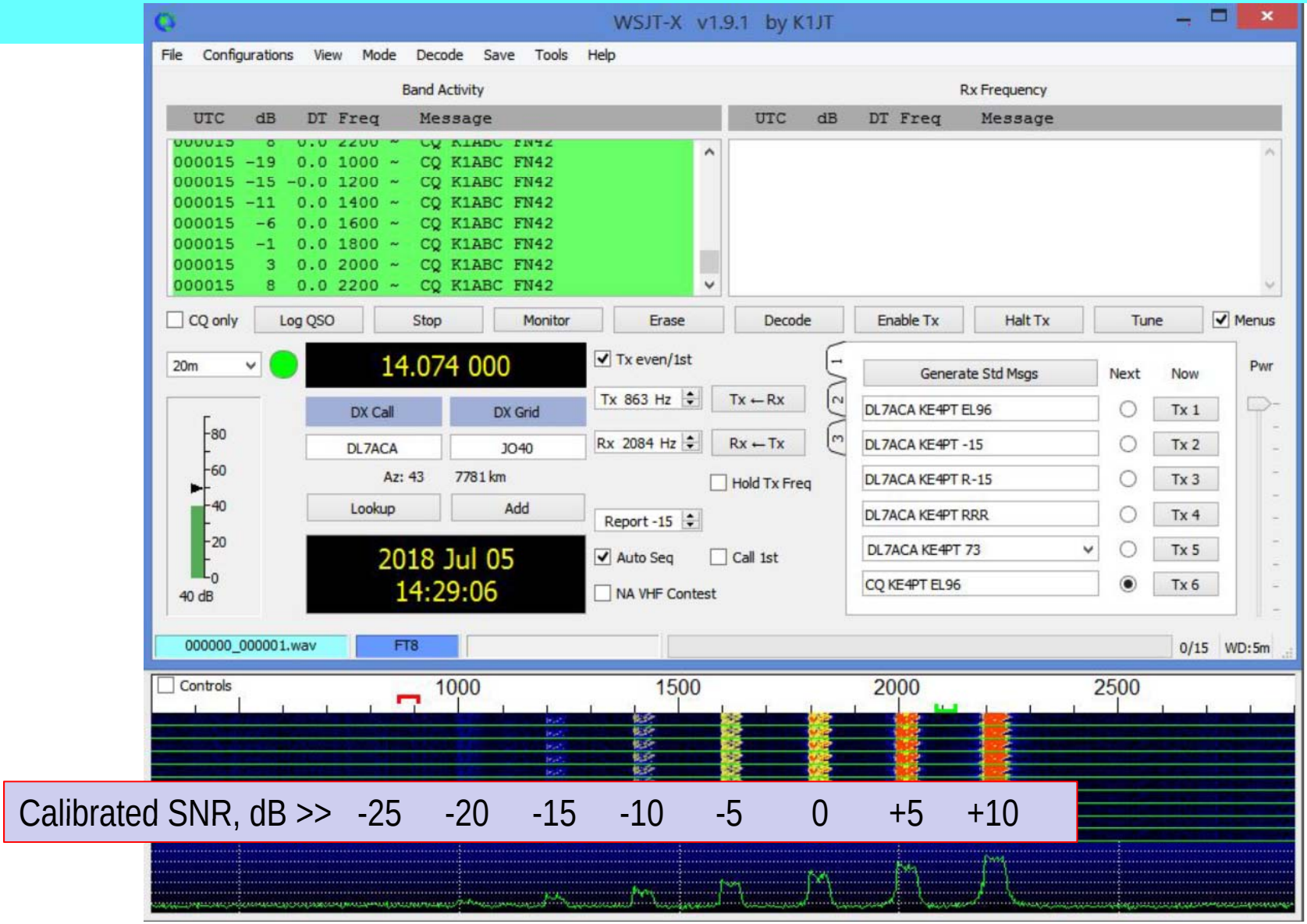
Bandwidths (BW) are for the narrowest submodes. S/N threshold is referenced to a 2,500 Hz bandwidth at a 50% probability for decoding of an unfading signal.

Mode	FEC type (n,k)	q m	Modulation	Keying rate, baud	BW, Hz	Sync energy fraction	TX duration, s	S/N threshold, dB
FT8	LDPC(174,87)	1 3	8-FSK	6.250	50.0	0.27	12.6	–20
JT4	C(206,72)	1 2	4-FSK	4.375	17.5	0.50	47.1	–23
JT9	C(206,72)	1 3#	9-FSK	1.736	15.6	0.19	49.0	–27
JT65	RS(63,12)	6 6#	65-FSK	2.692	177.6	0.50	46.8	–25
QRA64	QRA(63,12)	6 6	64-FSK	1.736	111.1	0.25	48.4	–26
WSPR	C(162,50)	1 2	4-FSK	1.465	5.9	0.50	110.6	–28

#Modulation includes one additional tone used for synchronization.

Source: Joe Taylor, K1JT, Steve Franke, K9AN, and Bill Somerville, G4WJS, "Work the World with WSJT-X, Part 2: Codes, Modes, and Cooperative Software Development", QST Nov. 2017.

FT8 at Various SNRs



Source: reference file for FT8 and posted at http://physics.princeton.edu/pulsar/k1jt/000000_000001.wav

Propagation Software: when to best use your Basic SDR System

- *Is there a viable propagation path?*
- *Tilt the propagation odds in your favor by planning!*

Use the free stand-alone HamCAP 1.9:

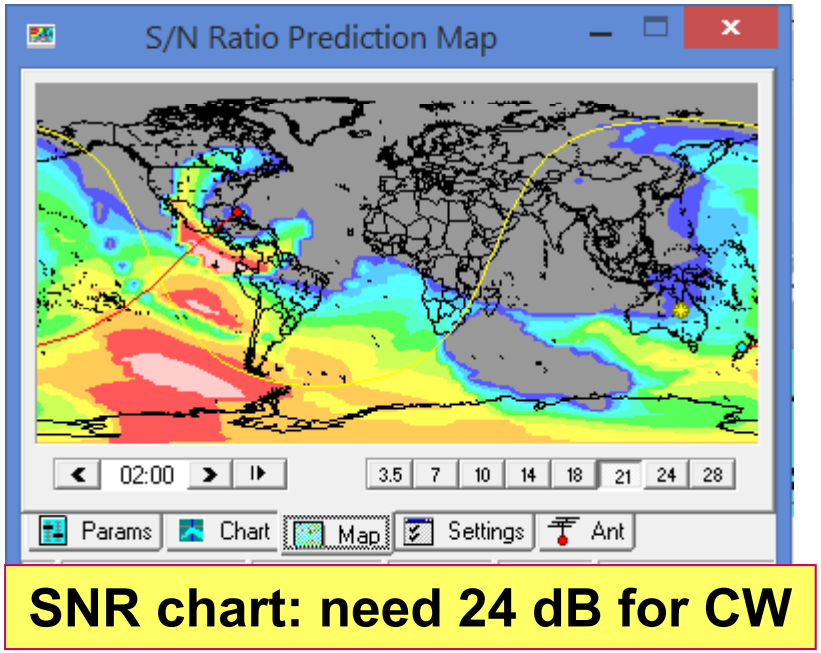
www.dxatlas.com/hamcap/

and / or:

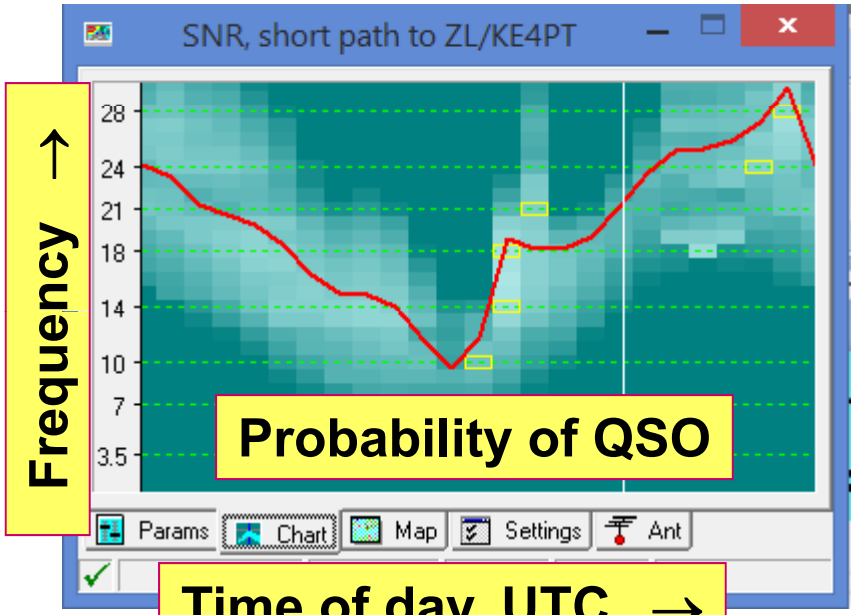
Use the free on-line VOACAP tool:

www.voacap.com/p2p/index.html

HamCAP 1.9 (Free!)



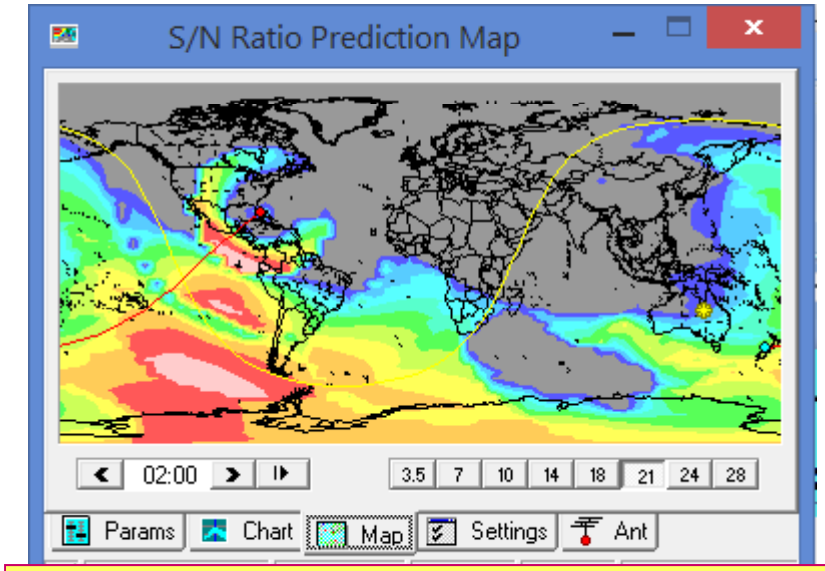
SNR chart: need 24 dB for CW

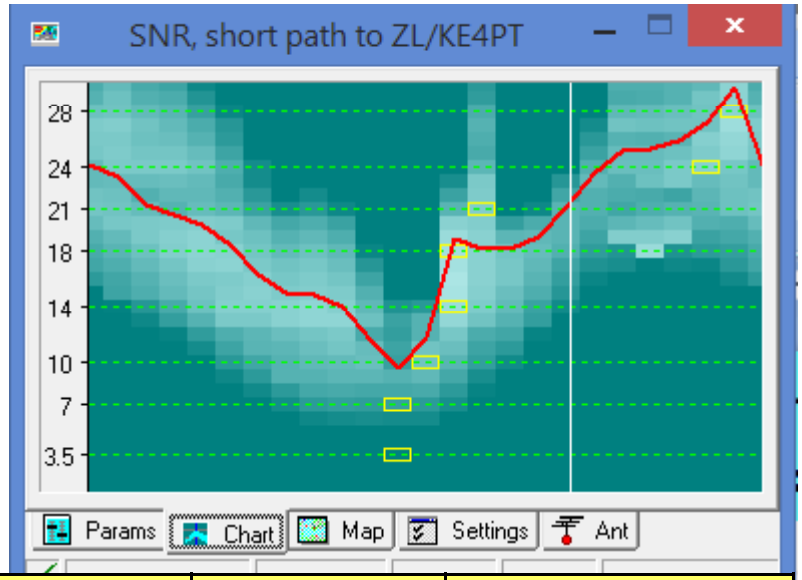


Time of day, UTC →

- VOACAP engine, GUI by Alex Shovkoplyas, VE3NEA
- Stand-alone or integrates with *IonoProbe* and *DXAtlas*
  www.dxatlas.com/Download.asp

Digital Modes with HamCAP



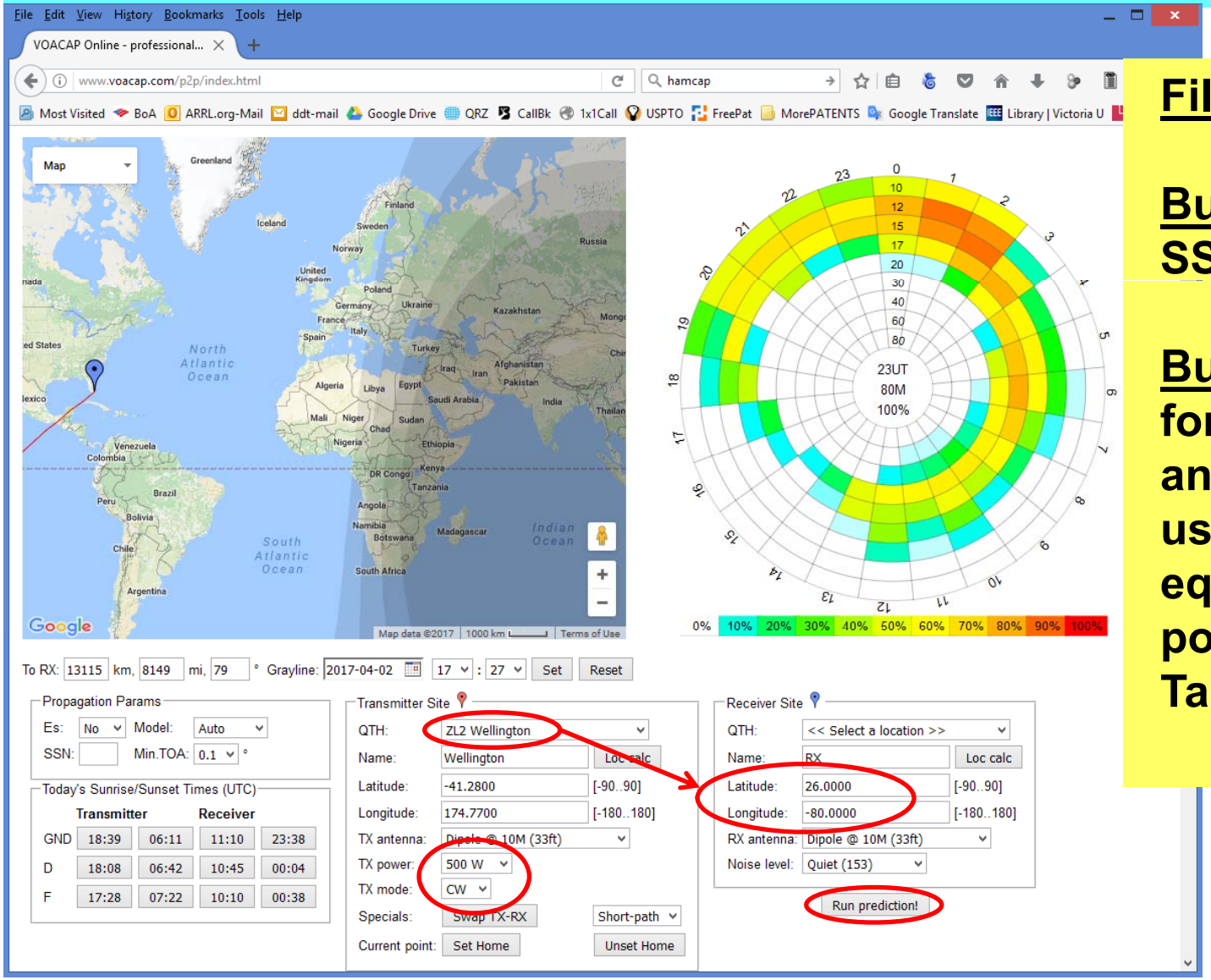


<u>SNR chart: need 24 dB for CW</u>, for other modes, *artificially* select an equivalent higher transmit power level according to the Table, then look for the 24 dB SNR levels on the map.

Mode	*Margin, dB*	*Equivalent Power, 5 W radio*
CW	0	5 W
PSK31	7	25 W
FT8	19	500 W
JT65	24	1,500 W

VOACAP Online for FREE General Use:

www.voacap.com/p2p/index.html

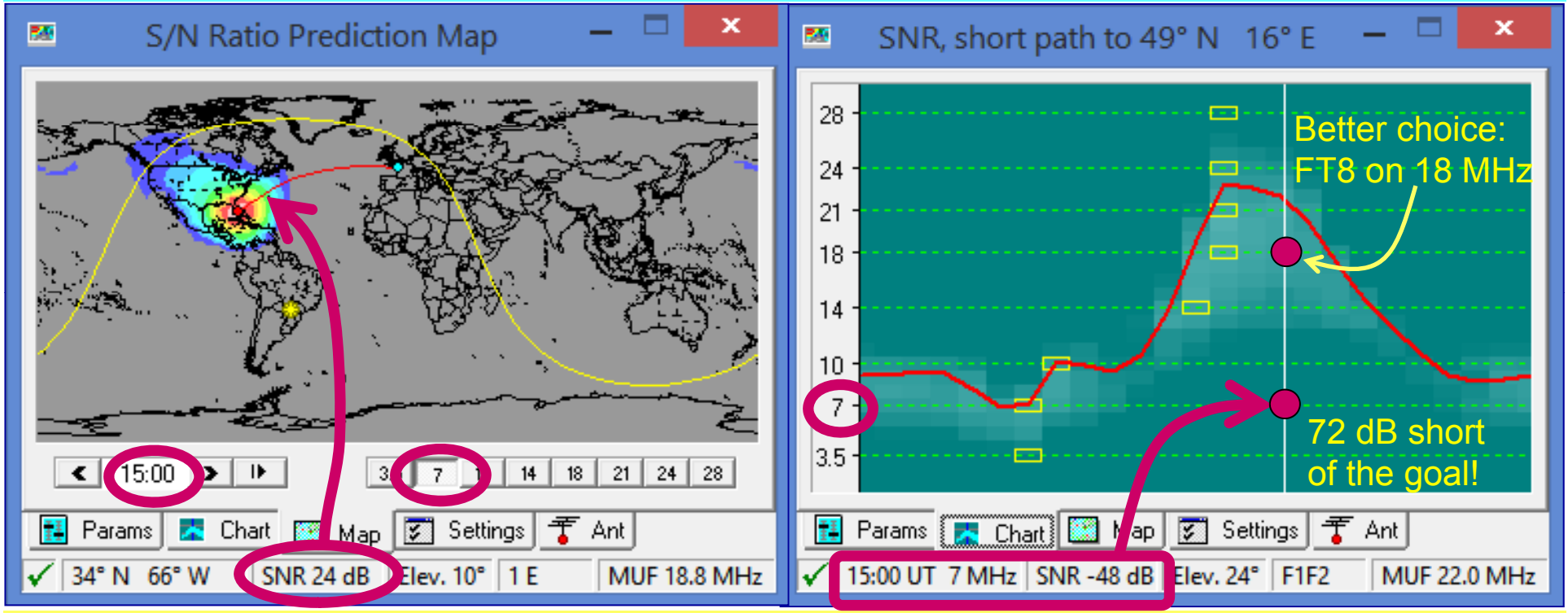


Fill in the blanks!

Built-in modes: CW, SSB, AM-broadcast

But: you can 'fool it' for JT65, JT9, FT8 and other modes by using the "inflated" equivalent transmit power from the Table!

“Great Expectations”



- **A local Ham set up a portable QRP station at a local park**
- **He expected to work Europe on 40 m CW with an inverted V antenna**
- **He worked just a single nearby station (within the yellow coverage contour)!** **PLAN BEFORE YOU GO – Avoid Disappointment!**

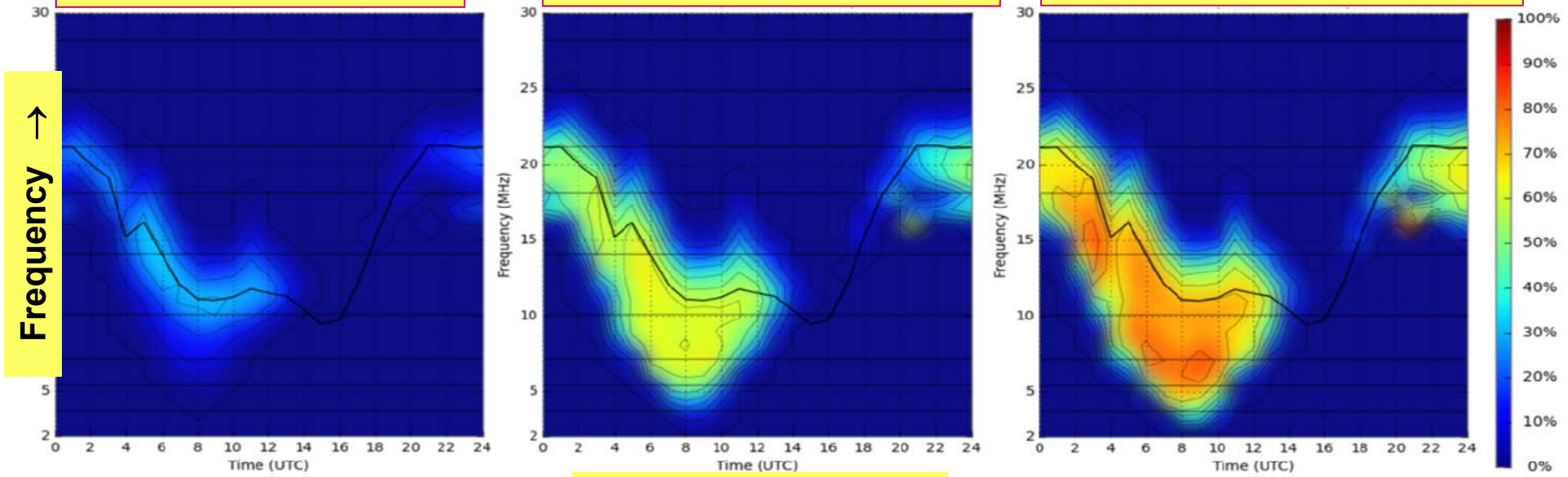
Planning before Going ZL ↔ FL

"Fool" www.voacap.com/prediction.html into predicting other digital modes:

For *CW* at 5 W:
Select 'CW' at 5 W

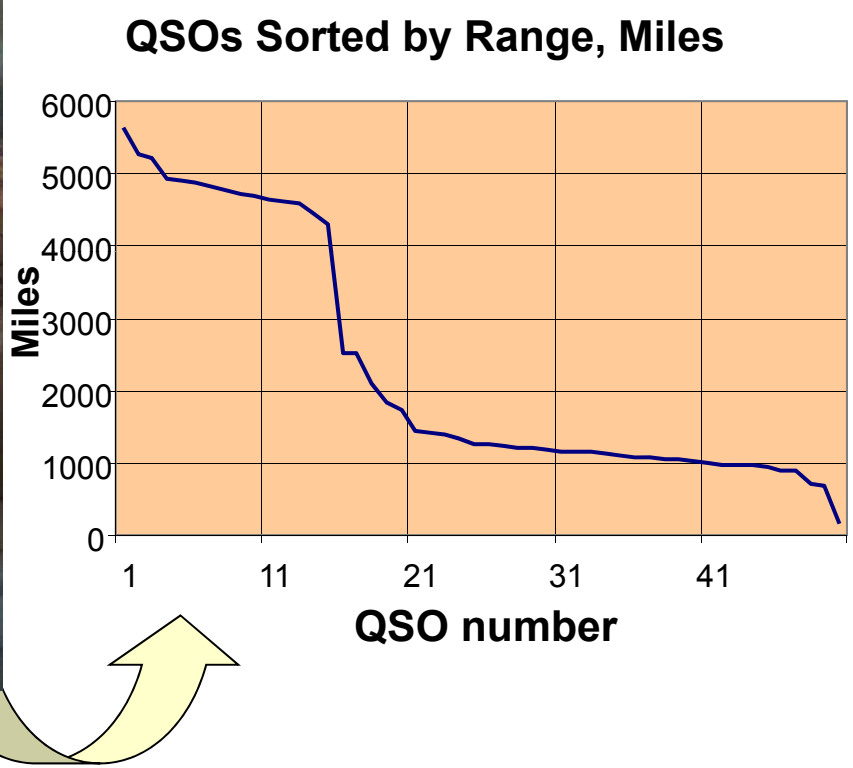
For *FT8* at 5 W:
Select 'CW' at 500 W

For *JT65* at 5 W:
Select 'CW' at 1500 W



Bonus: for PSK31 at 5 W select 'CW' at 25 W

More Planning:
Living Room and Field Testing



Initial tests from inside my Coral Springs, FL living room: **demonstrated 5,630 mile path**

However…
The ZL ↔ FL path is 8,135 miles!

Further tests from Vista View Park in Broward County, FL; **verified the equipment list**

Putting it into Practice ZL ↔ FL
(there were some ‘gravity’ issues)

Image by Chris Dean, KD7CNJ

Consulted a Wizard…

…or was it the software??

(got my hat back)

That's the Theory!

What about the Practice?

Propagation Prediction ZL ↔ FL

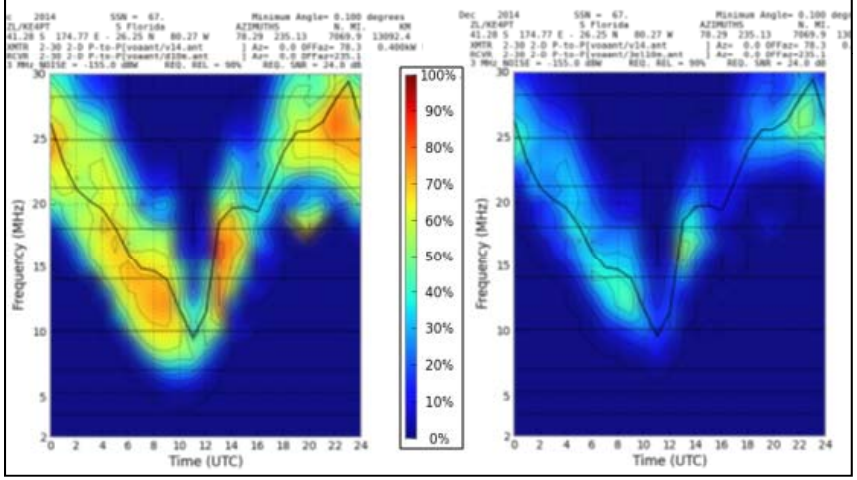
www.voacap.com/prediction.html

JT65 at 5 W (same as CW at 500 W)

Circuit Reliability (%)

CW at 5 W

Circuit Reliability (%)



?

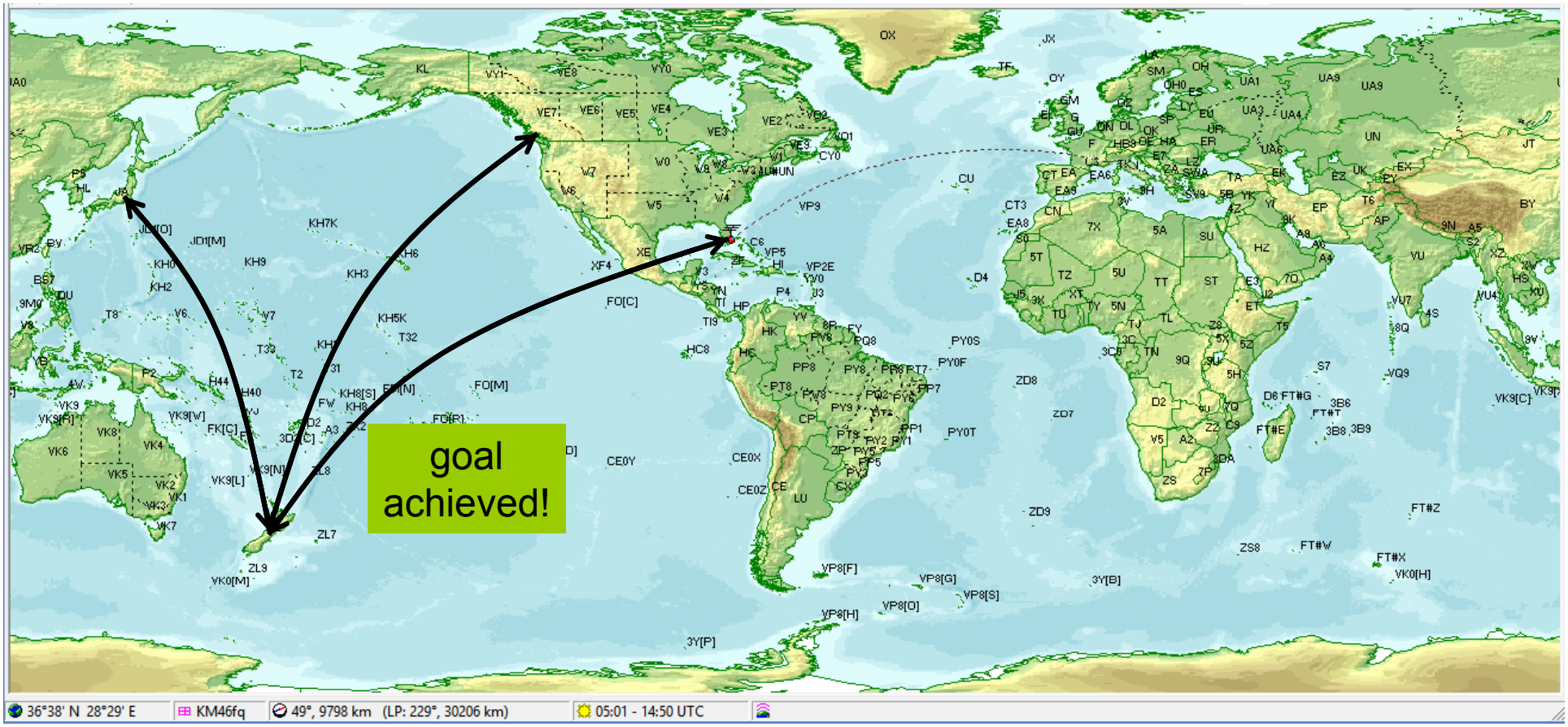
- **JT65 should be robust,**
- **CW will be "iffy"**

Wizard's Choice of Portable Station Sites

JT65 from Frank Kitts Park, Wellington, New Zealand, **radio site #1**

CW from Mount Victoria, Wellington, New Zealand, **radio site #2**

Worked Three Countries on JT65



There is a lot of Pacific Ocean between ZL and populous land masses to East and North East: **it's 8,100 miles or nothing!**

Results

Contacts followed predictions!

- 2 hours allocated for JT65, made a handful of contacts in 3 countries
  - *best was 3,254 miles per watt*
- 2 hours allocated for CW, but no contacts!


Thank You,
73, es gd DX
de KE4PT