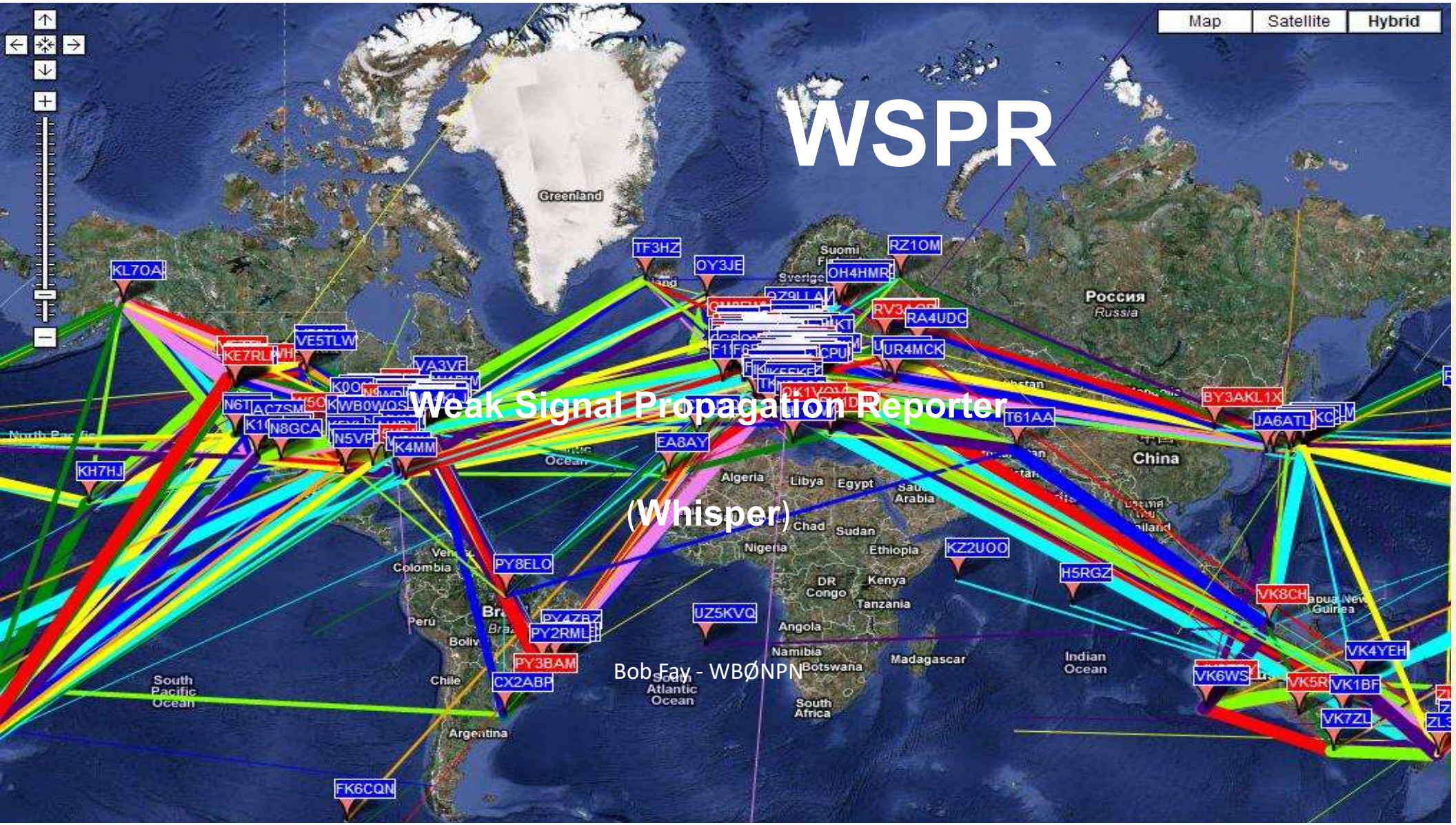

WSPR
Weak Signal Propagation Reporter
(Whisper)
Bob Fay - WBØNPN
Map
Satellite
Hybrid
Greenland
Россия
Russia
China
Suomi
Sverige
Algeria
Libya
Egypt
Chad
Sudan
Nigeria
Ethiopia
Kenya
Tanzania
Angola
Namibia
Botswana
Madagascar
South Africa
Indian Ocean
South Pacific Ocean
Chile
Argentina
Peru
Colombia
Papua New Guinea
KL7OA
VE5TLW
KE7RL
N8GCA
N5VP
K4MM
KH7HJ
TF3HZ
OY3JE
OH4HMR
RZ1OM
RA4UDC
UR4MCK
EA8AY
T61AA
BY3AKL1X
JA6ATL
KZ2UOO
H5RGZ
VK8CH
VK4YEH
VK6WS
VK5R
VK1BF
VK7ZL
PY8ELO
PY2RML
PY3BAM
CX2ABP
UZ5KVQ
FK6CQN

WSPR

- What's the purpose of WSPR?
  - Propagation Study
  - Weak Signal Experimentation
  - Antenna Characteristics

WSPR

- It is a one way communication mode
  - Transmit a signal, and the receiving station displays it and can report reception via internet.
  - Receive a signal, and it is displayed and can report it to the internet.
  - Stations do not directly connect. Different than modes such as FT-8

WSPR

- Where do you see the results and what do they look like?
  - On your computer screen
  - www.wsprnet.org on the internet
  - wspr.aprsinfo.com

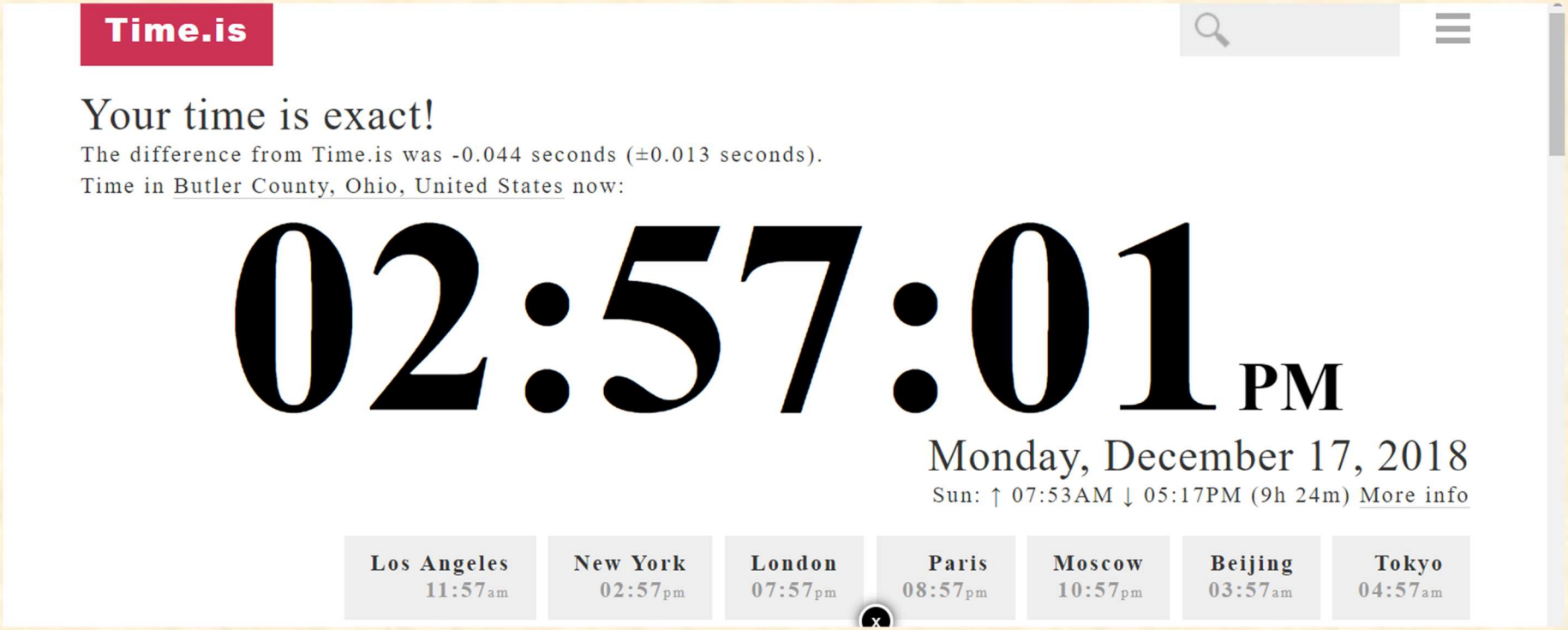
WSPR - Background

- WSPR software developed by Joe Taylor, K1JT- Princeton Physics Prof.
- Initially released in April, 2008
- It is designed to study propagation using low power and weak received signals.
- It uses a transmission mode called MEPT-JT.
- Manned Experimental Propagation Transmitter, and the JT represents Joe Taylor's initials.
- "Manned" means the transmissions must be under the control of an operator to comply with FCC regulations.
- Originally released as stand alone software. Now incorporated into WSJT-X. Being phased out is WSPR2.12, latest stand alone version.

WSPR – Basic Information

- WSPR software incorporates both receive/decoder and transmitter functions.
- WSPR operation is completely automatic once the software has been programmed.
- The transmitted signal is FSK (Frequency Shift Keying – F1D).
- It is a digital transmission.
- Accurate time is essential, and the computer clock must be accurately synchronized with a time standard, to within a few seconds.

WSPR – Time Standard
www.time.is



WSPR – How It Functions

- Each transmission starts 1 second after the start of each even numbered minute.
- Transmission consists of call sign, grid square, and power (dBm)
- Transmission is slightly less than two minutes (110.6 sec)
- Thus, it is a very slow baud rate (1.4648 Hz), and occupies about 6 Hz bandwidth.
- Latest WSPR (WSJT-X) software can copy a signal at S/N ratio of -31 dBm level.
- The frequency window for WSPR is 2500 Hz, so many stations can occupy the frequency. Receive software looks at a 200 Hz window.
- Stations specify in the software the time between transmissions – in % of time transmitting. If 20% is specified in setting the software, transmission will be 20 out of every 100 minutes. Since the transmission is about 2 minutes, 10 transmission every 100 minutes will occur. With stations specifying different time intervals, collisions are minimized.

WSPR Frequencies

- WSPR operates on USSB
  - Band Dial freq (MHz) Tx freq (MHz)
  - 160m 1.836600 1.838000 - 1.838200
  - 80m 3.592600 3.594000 - 3.594200
  - 60m 5.287200 5.288600 - 5.288800
  - 40m 7.038600 7.040000 - 7.040200
  - 30m 10.138700 10.140100 - 10.140300
  - 20m 14.095600 14.097000 - 14.097200
  - 17m 18.104600 18.106000 - 18.106200
  - 15m 21.094600 21.096000 - 21.096200
  - 12m 24.924600 24.926000 - 24.926200
  - 10m 28.124600 28.126000 - 28.126200
  - 6m 50.293000 50.294400 - 50.294600
  - 2m 144.488500 144.489900 - 144.490100

WSPR – How It Functions

- Software uses encoding and forward error correction.
- No variations are allowed in call sign. No addendums, etc.
- Total of 50 bits in each transmission
  - 28 bits for call sign
  - 15 bits for location (Grid Square)
  - 7 bits for power
- This is the only information transmitted.

WSPR – Operational Methods

- What do you want to do on WSPR?

- Transmit Only
- Receive Only
- Transmit & Receive

WSPR

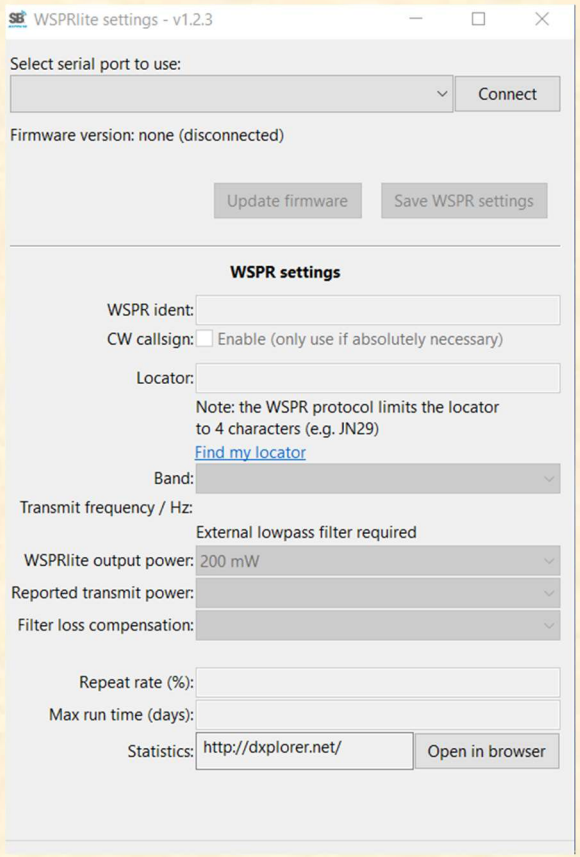
- Equipment Required

- Receive and/or transmit
  - Transceiver
    - Capable of covering the bands of interest.
    - Capable of transmitting at low power – about 5 watts works well.
    - Computer/transceiver interface (Signal-Link, etc) if transceiver does not directly interface to computer.
  - Computer
    - Capable of running current software version – WSJT-X
    - Windows 7 or higher

WSPR

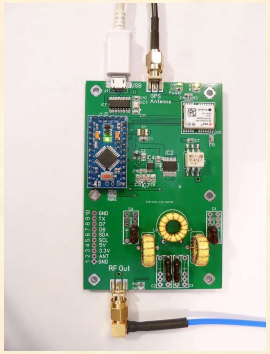
- Transmit Only
  - Several equipment types are available
    - WSPRLITE – Manufactured by SOTABEAMS – UK
    - Available from DX-Engineering
    - USB powered
    - RF Power output from 5 to 200 mw.
    - Standard version covers 630 through 20 m.
    - Flexi model through 6 m.
    - Requires additional external low pass band filter for other than 30 m & 20 m.
    - Use downloaded configuration and driver software to install and set parameters.
    - Computer used for configuration only – stand alone operation when transmitting.
    - Price range - $80 to $100 depending on model.
    - Download from https://www.sotabeams.co.uk/downloads/

Setup Screen For WSPRLite



WSPR

- WSPR_TX_LP1 Transmitter
  - Functions similar to the WSPRLITE
  - Has built in GPS to maintain time sync.
  - GPS will calculate the grid square.
  - Max 300 mw output power
  - Low pass band filter has to be constructed on board by user.
  - Covers 136 kHz to 70 Mz.
  - USB powered.
  - Open source software and schematic available on Github.
  - Company is ZachTec. Harry Zachrisson, SM7PNV – Apparently only available ordering from Sweden.
  - Have not seen it in operation. You have to add band pass filters.
  - https://www.zachtek.com/product-page/wspr-tx-lp1-transmitter



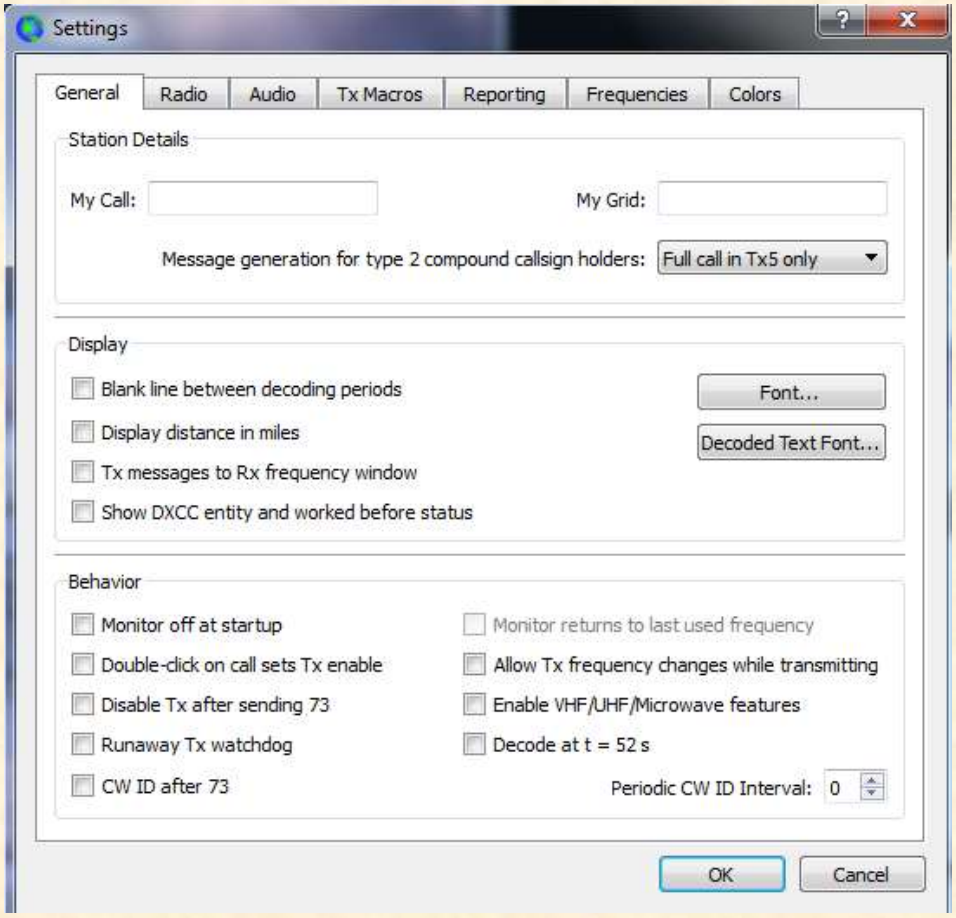
WSPR – Software – Transmit & Receive

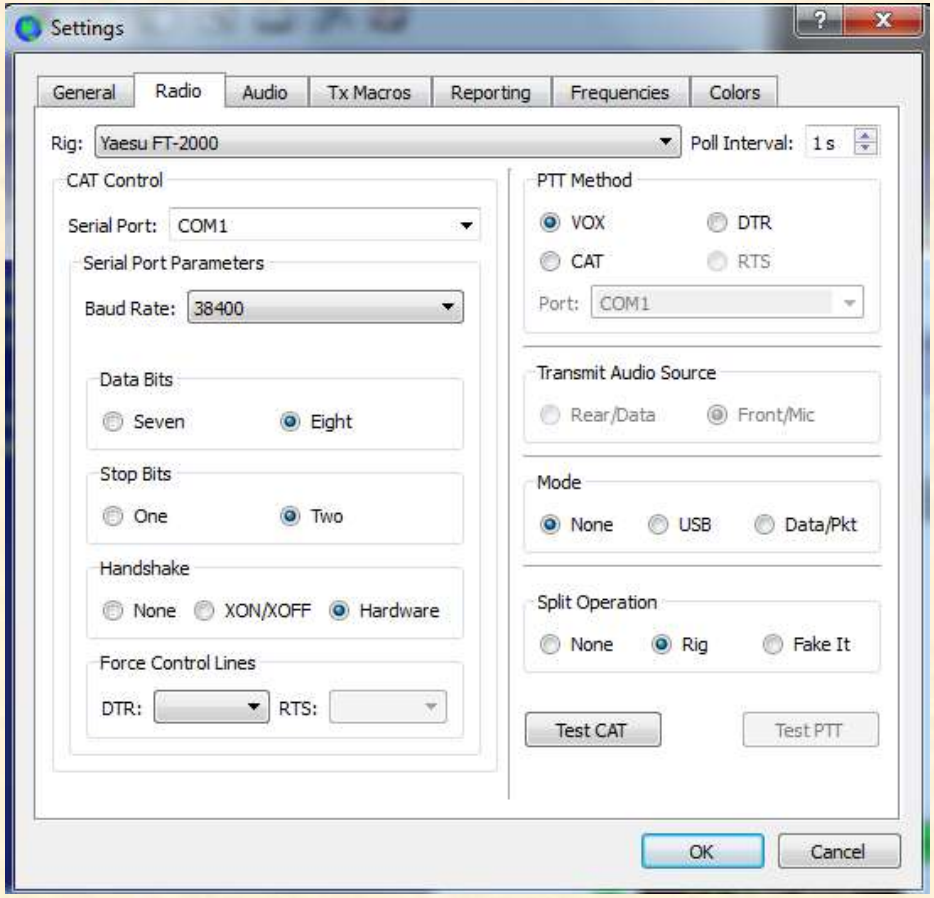
- As of January 1, 2019, recommended operation is shifting to **WSJT-X,** version 2.0.0, which incorporates the WSPR software.
- WSJT-X also supports **FT8, JT4**, **JT9**, **JT65**, **QRA64**, **ISCAT**, **MSK144.**
- Changes have been made in every mode, and are not backward compatible in some modes (not WSPR).
- Also supports **ECHO**, designed to let you monitor your signals reflected from the moon.
- WSJT-X software and instructions downloads from
  https://physics.princeton.edu/pulsar/k1jt/wsjtx.html
- Release notes available at
  https://physics.princeton.edu/pulsar/k1jt/Release_Notes.txt

WSPR – Transmit & Receive

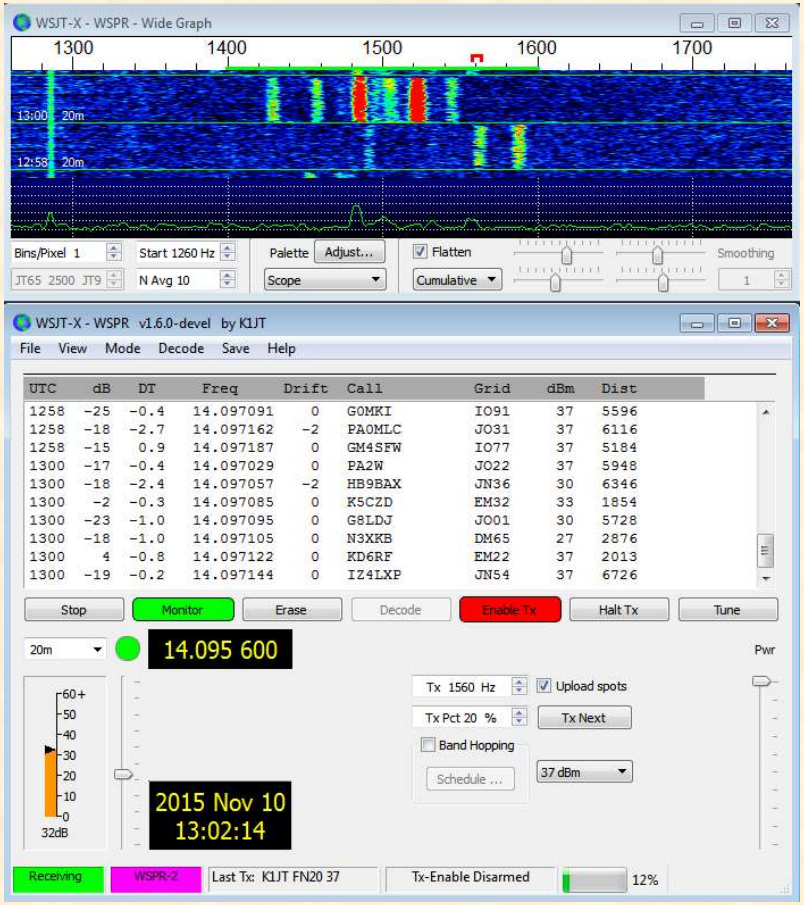
- Downloading WSJT-X – Very straight forward and fast.
  - Download from the site on the previous page.
  - Follow directions for saving on the computer.
  - Follow setup instructions.
  - Set up interface between transceiver and computer.
    - Follow on screen instructions and those of your transceiver and interface.
    - Basic information – Call Sign, Grid Square, Com Port, etc.
    - LOL

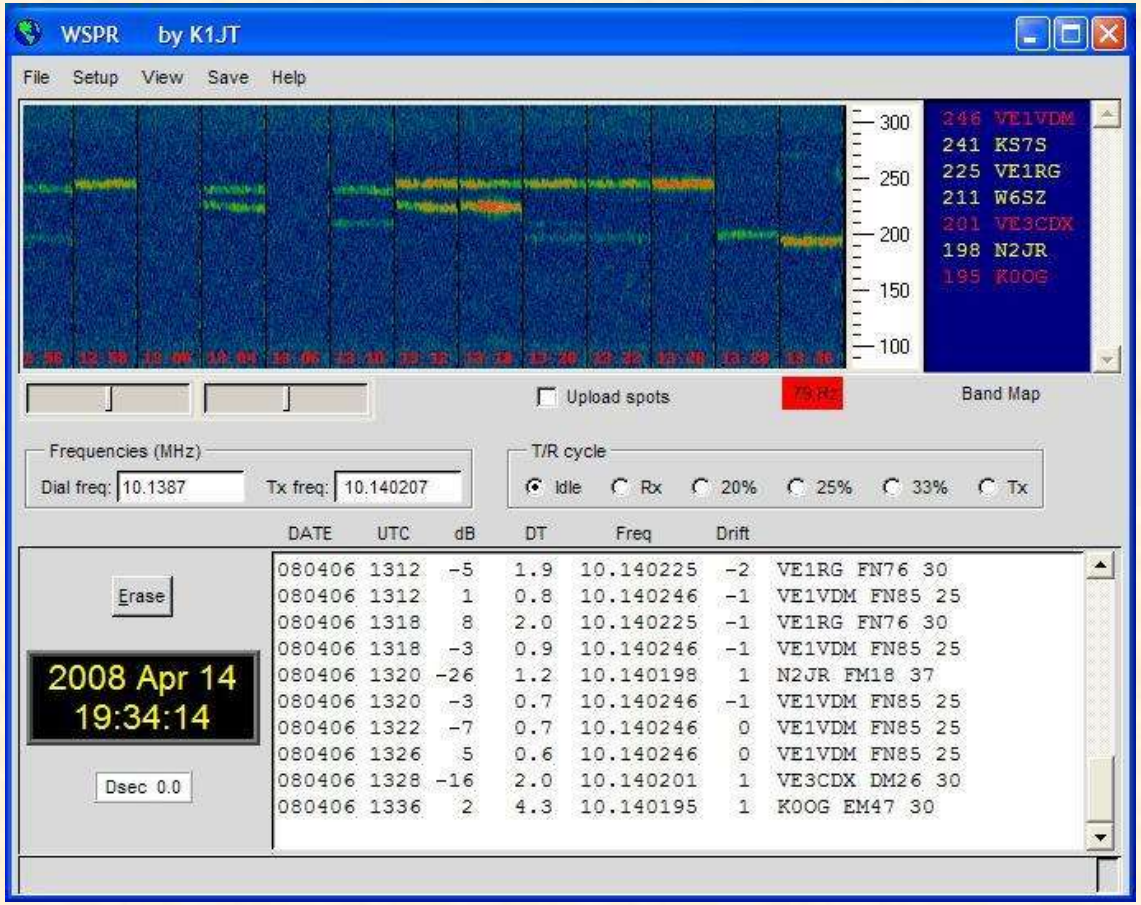
WSJT-X Initial Installation Setup





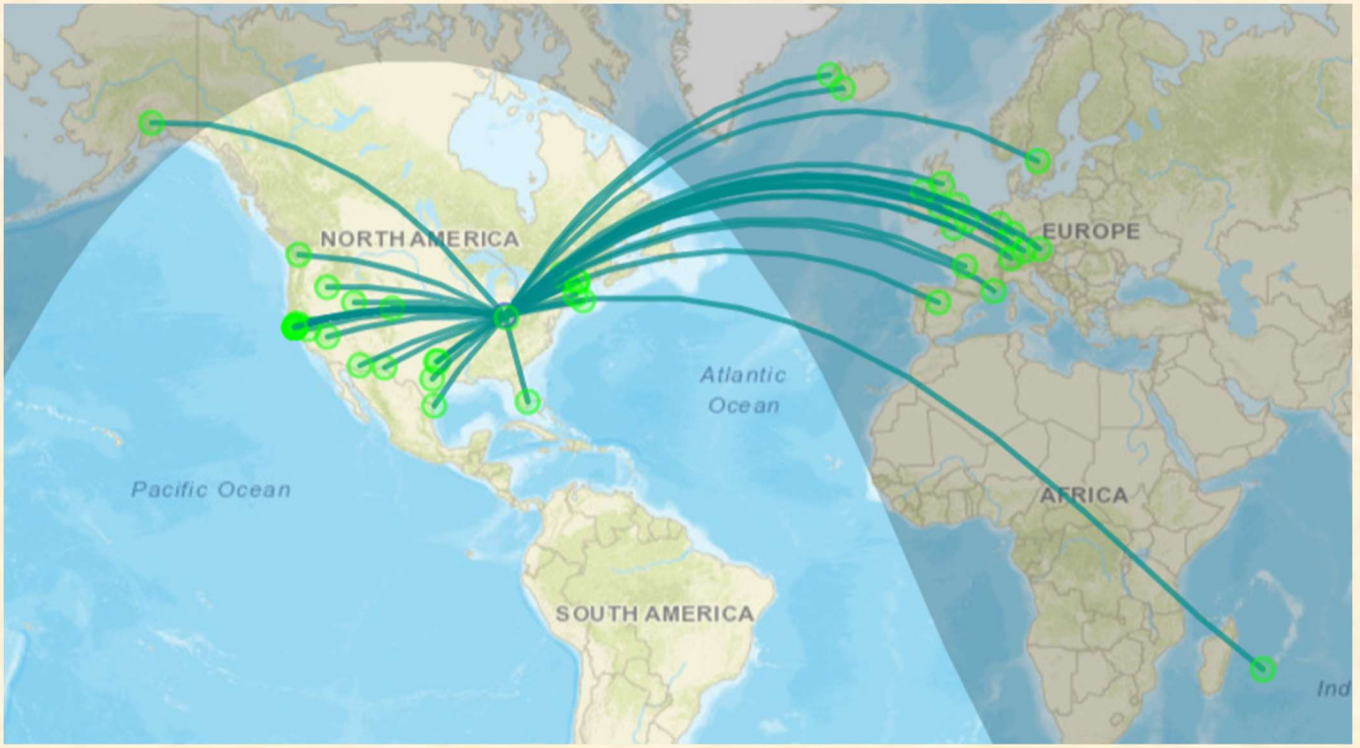
WSJT-X WSPR Mode Screen WSPR 2



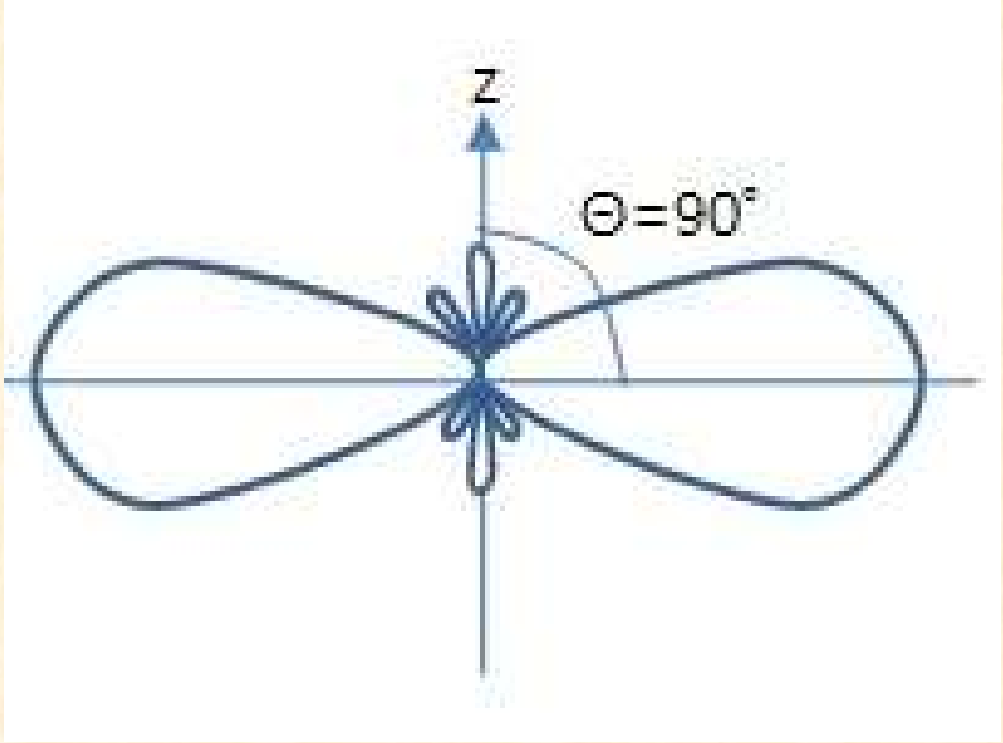


WSPR – WBØNPN Propagation

Two 14AVQ Verticals Phased For 20 m & Oriented Toward Europe & SW US
Yields Figure 8 Wave Pattern



Wave Pattern For 2 Broadside Verticals Spaced 0.5 Wavelength Apart (Feed In Phase)



WSPR – Practical Application

- On December 19 & 20, 2018 – KD8ZUY & WBØNPN used WSPR to compare the performance of the Rhombic test antenna and the Cushcraft Tri-Band beam on the west side of the building.
- Two WSPRLite transceivers operating at 200 mw on 20 m were connected to the antennas and placed in transmit mode for 24 hours.
- Prints were made of the transmission paths at various time intervals over this 24 hour period.
- Data was retrieved from the wsprnet.org website.
- Calculation of the received S/N data was made by recording 100 received samples for each antenna, and calculation the average S/N reported.

WSPR – Practical Application

West Chester Amateur Radio Association
Comparison Test - West Tri-Band Beam to Beta Test Rhombic Antenna
Conducted by KD8ZUY & WBØNPN - 24 Hour Period - Dec. 19 & 20 - 7:00 PM to 7:00 PM
Equipment - WSPRLite Transmitter - 200 mw Sample Size - 100
Rhombic S/N gain over Tri-Bander - +2.47 db on 20 m

Cushcraft Tri-Bander

Timestamp	Call	MHz	SNR	Drift	Grid	Pwr	Reporter	RGrid	km	az
2018-12-20 23:02	WB0NPN	14.09708	-28	0	EM79tm	0.2	WA5DJJ	DM62ph	2158	255
2018-12-20 22:52	WB0NPN	14.09707	-8	-1	EM79tm	0.2	KA7OEI-1	DN31uo	2359	285
2018-12-20 22:52	WB0NPN	14.09707	-23	-2	EM79tm	0.2	KC5AM	DM65pd	2028	263
2018-12-20 22:52	WB0NPN	14.09707	-15	-1	EM79tm	0.2	NO5V	EL15gw	1939	223
2018-12-20 22:40	WB0NPN	14.09708	-28	-1	EM79tm	0.2	WA5DJJ	DM62ph	2158	255
2018-12-20 22:40	WB0NPN	14.09707	-13	-1	EM79tm	0.2	KA7OEI-1	DN31uo	2359	285
2018-12-20 22:40	WB0NPN	14.09709	-17	-1	EM79tm	0.2	KA8HUZ	EM79wk	23	113
2018-12-20 22:26	WB0NPN	14.09708	-1	-1	EM79tm	0.2	KG5LBS	EM10bf	1604	234
2018-12-20 22:24	WB0NPN	14.09707	-21	-1	EM79tm	0.2	KA7OEI-1	DN31uo	2359	285
2018-12-20 22:24	WB0NPN	14.09709	-16	-1	EM79tm	0.2	KA8HUZ	EM79wk	23	113
2018-12-20 22:24	WB0NPN	14.09708	-9	-2	EM79tm	0.2	KG5LBS	EM10bf	1604	234
2018-12-20 22:12	WB0NPN	14.09707	-18	0	EM79tm	0.2	N6GN/K2	DN70jo	1773	281

West Chester Amateur Radio Association
Comparison Test - West Tri-Band Beam to Beta Test Rhombic Antenna
Conducted by KD8ZUY & WBØNPN - 24 Hour Period - Dec. 19 & 20 - 7:00 PM to 7:00 PM
Equipment - WSPRLite Transmitter - 200 mw Sample Size - 100
Rhombic S/N gain over Tri-Bander - +2.47 db on 20 m

Rhombic Antenna

Timestamp	Call	MHz	SNR	Drift	Grid	Pwr	Reporter	RGrid	km	az
2018-12-20 23:10	KD8ZUY	14.09708	-22	1	EM79	0.2	KB4DXV	DM42mf	2461	259
2018-12-20 23:00	KD8ZUY	14.09708	-25	0	EM79	0.2	KB4DXV	DM42mf	2461	259
2018-12-20 23:00	KD8ZUY	14.09707	-21	0	EM79	0.2	WA5DJJ	DM62ph	2101	254
2018-12-20 22:50	KD8ZUY	14.09706	-16	0	EM79	0.2	NO5V	EL15gw	1898	221
2018-12-20 22:50	KD8ZUY	14.09708	-24	0	EM79	0.2	KB4DXV	DM42mf	2461	259
2018-12-20 22:50	KD8ZUY	14.09707	-28	0	EM79	0.2	WA5DJJ	DM62ph	2101	254
2018-12-20 22:50	KD8ZUY	14.09706	-9	0	EM79	0.2	KA7OEI-1	DN31uo	2305	285
2018-12-20 22:38	KD8ZUY	14.09706	-18	0	EM79	0.2	KC5AM	DM65pd	1970	263
2018-12-20 22:38	KD8ZUY	14.09708	-17	0	EM79	0.2	KA8HUZ	EM79wk	79	93
2018-12-20 22:38	KD8ZUY	14.09707	-20	0	EM79	0.2	KG5LBS	EM10bf	1556	233
2018-12-20 22:38	KD8ZUY	14.09706	-7	0	EM79	0.2	KA7OEI-1	DN31uo	2305	285
2018-12-20 22:26	KD8ZUY	14.09706	-13	0	EM79	0.2	KC5AM	DM65pd	1970	263
2018-12-20 22:24	KD8ZUY	14.09707	3	0	EM79	0.2	KG5LBS	EM10bf	1556	233

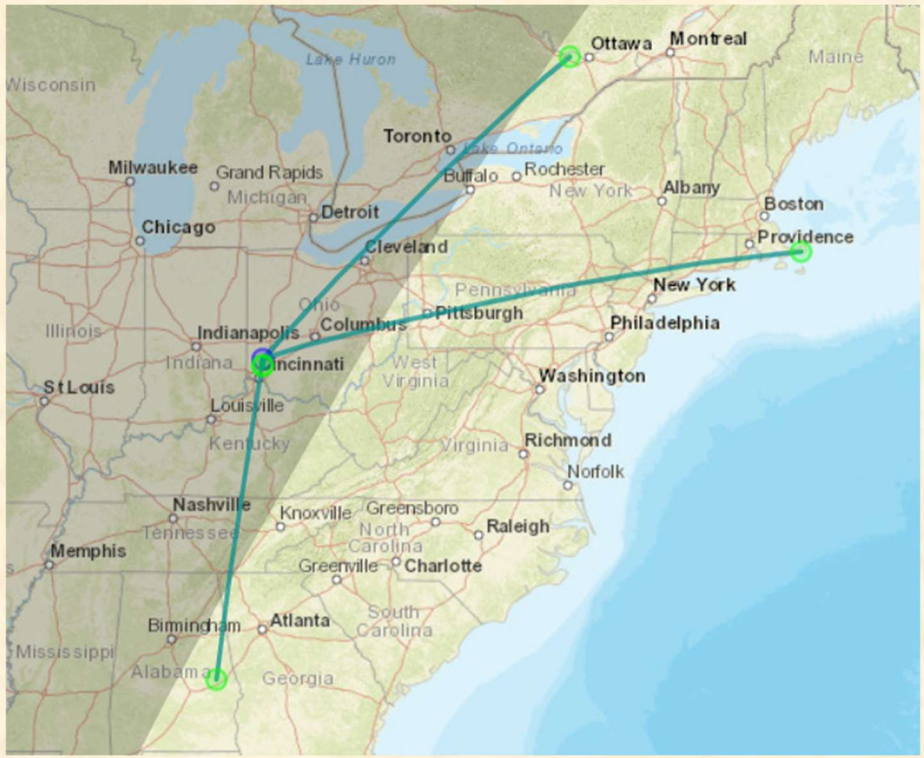
WSPR – Practical Application

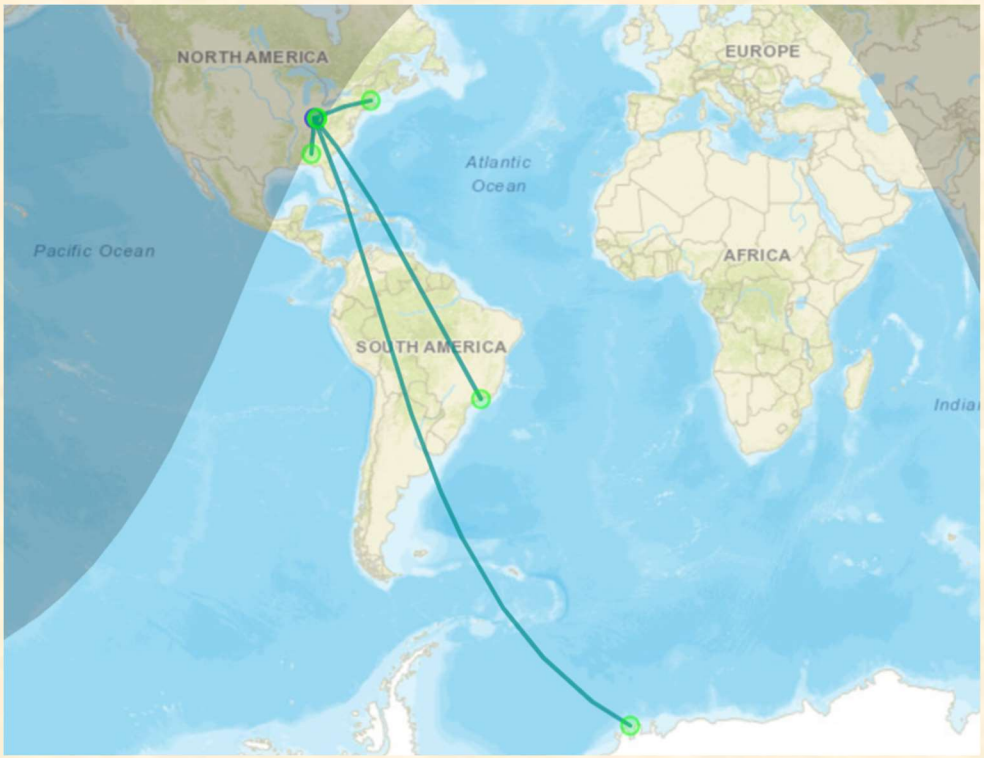
- The +2.47 db gain means the Rhombic antenna is delivering a signal almost double in strength as that of the beam.
  - (3 db is exactly twice the signal strength)
- Exactly what we wanted to achieve in construction the Rhombic!
- Congratulations to all who participated in the design, construction, and erection of the Rhombic.

WSPR – Propagation Evaluation

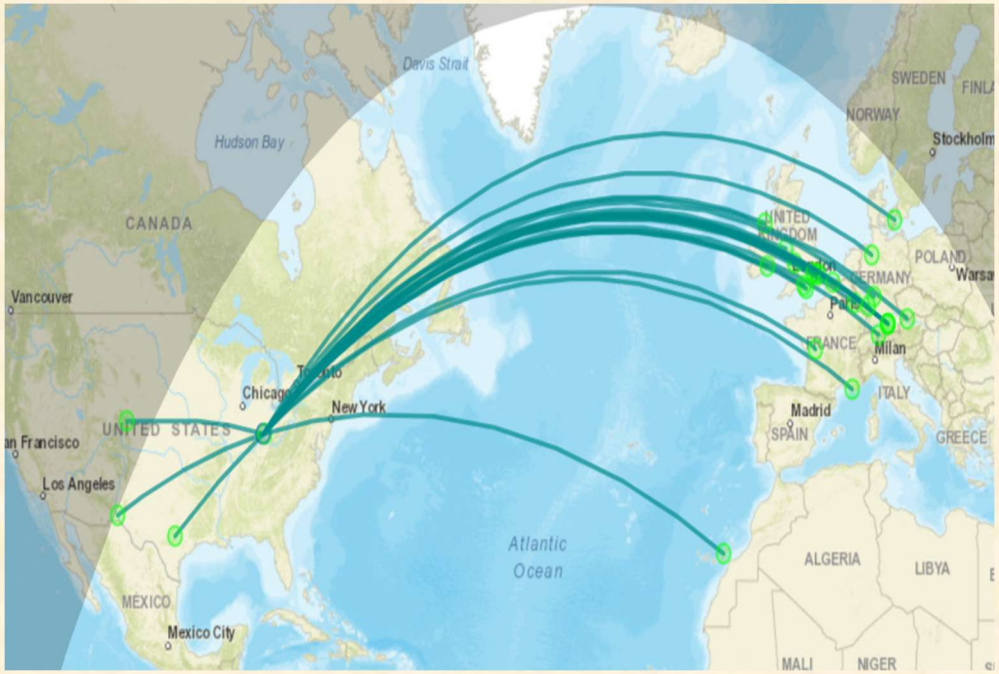
- The following slides represent copies of the propagation path reports over several hours of observation.

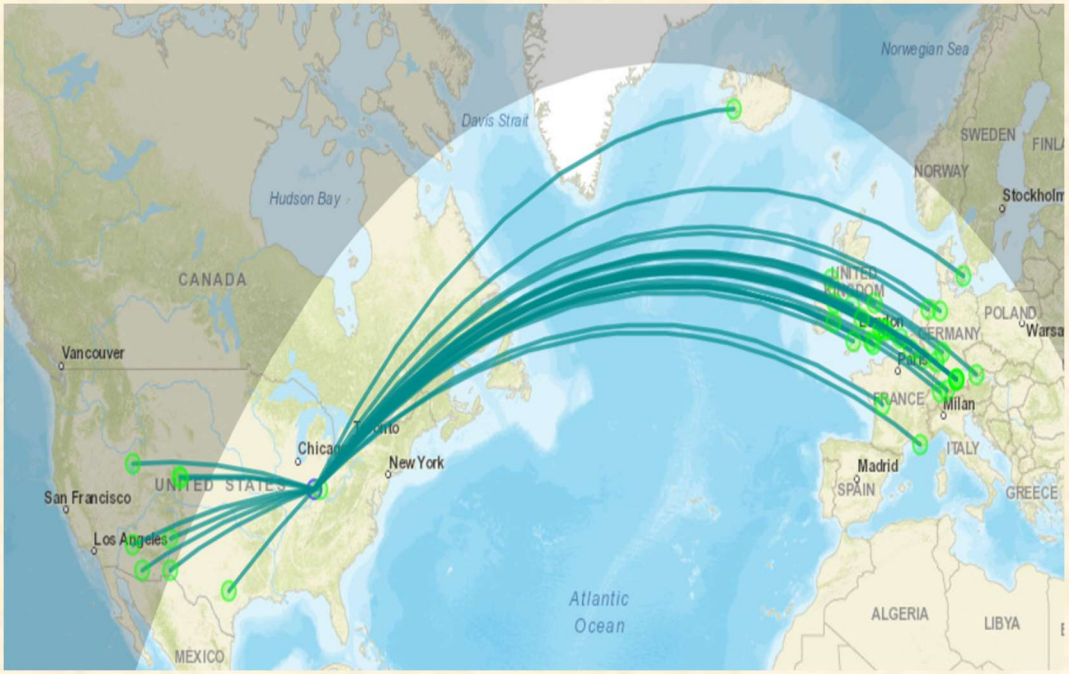
Propagation overnight – Dec. 19. (12 hour period)
Beam antenna on left, Rhombic on the right.
Screen copies made at 7:00 AM Dec. 20.



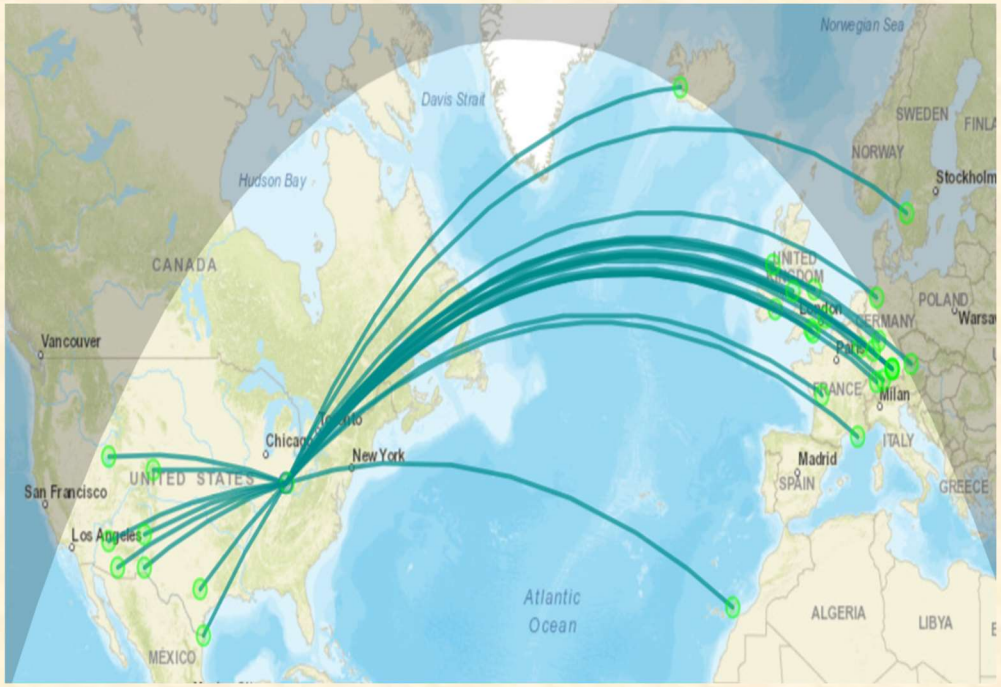


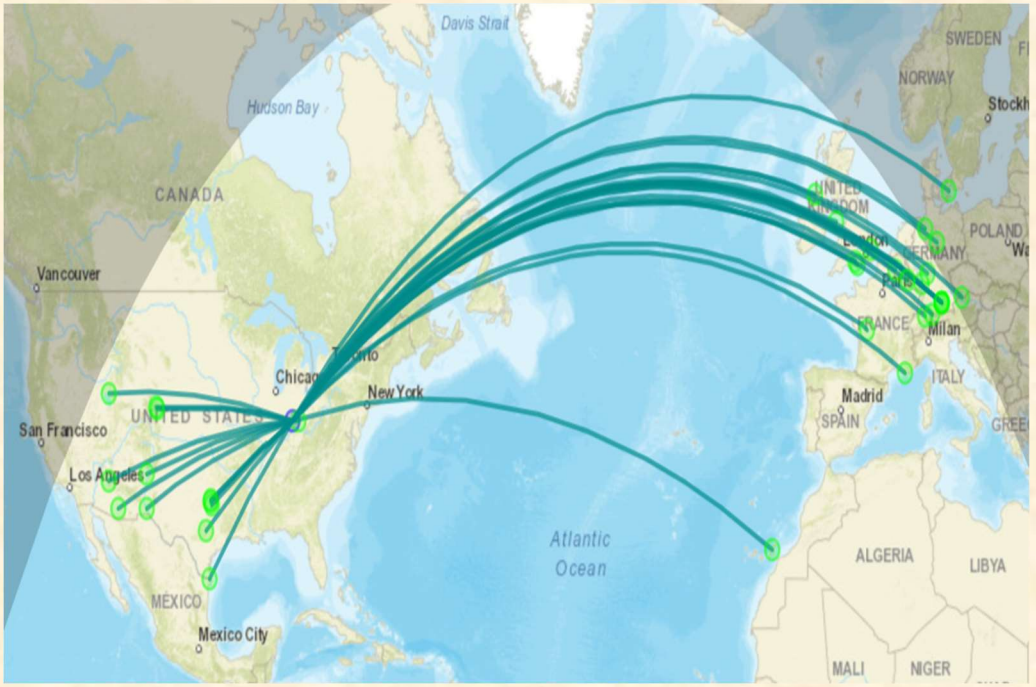
Propagation over a one hour period – 8 am to 9 am – Dec. 20
Beam on the left – Rhombic on the right



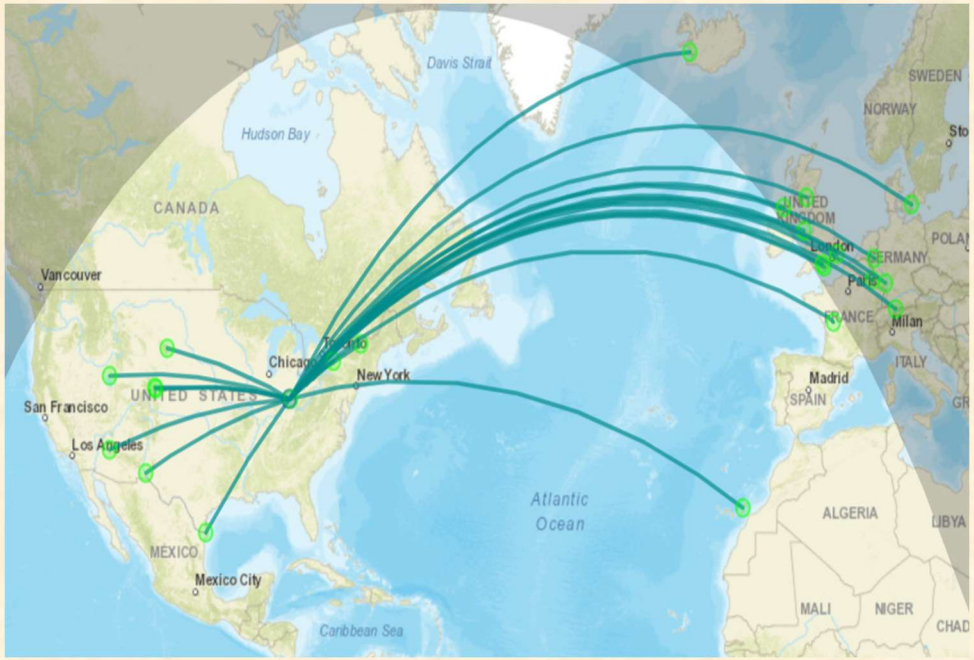


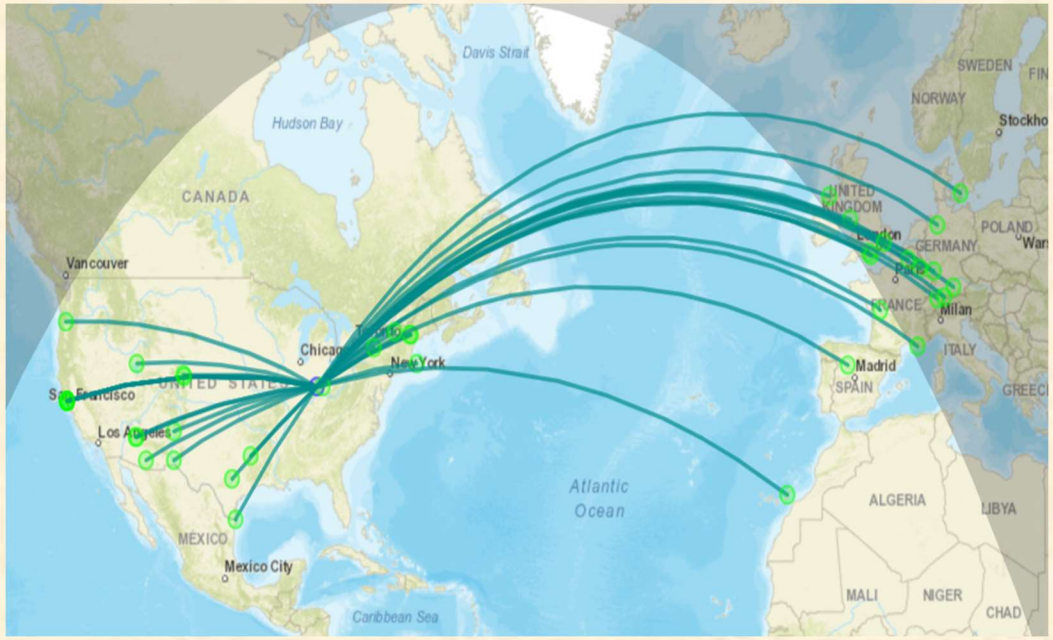
Propagation over a one hour period – 9 am to 10 am – Dec. 20
Beam on the left – Rhombic on the right



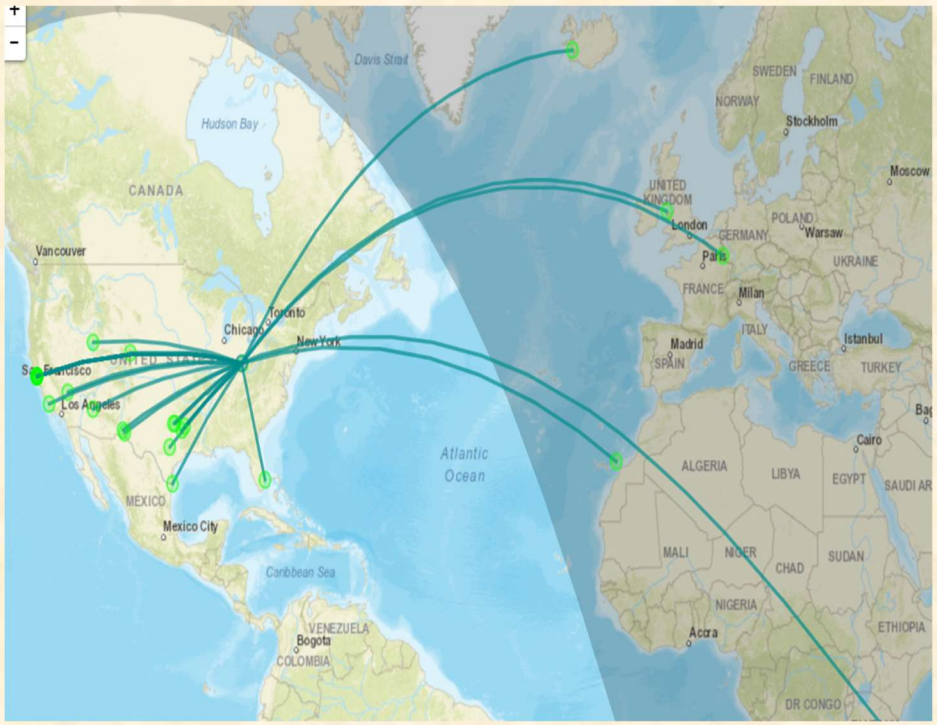


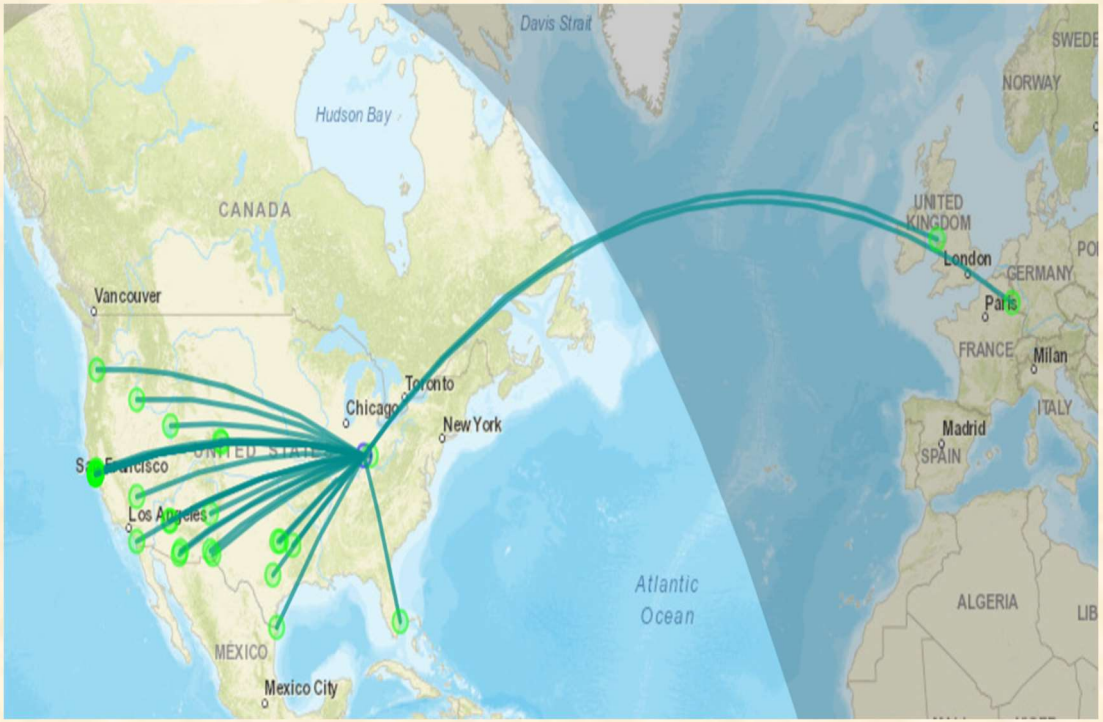
Propagation over a one hour period – 10 am to 11 am – Dec. 20
Beam on the left – Rhombic on the right



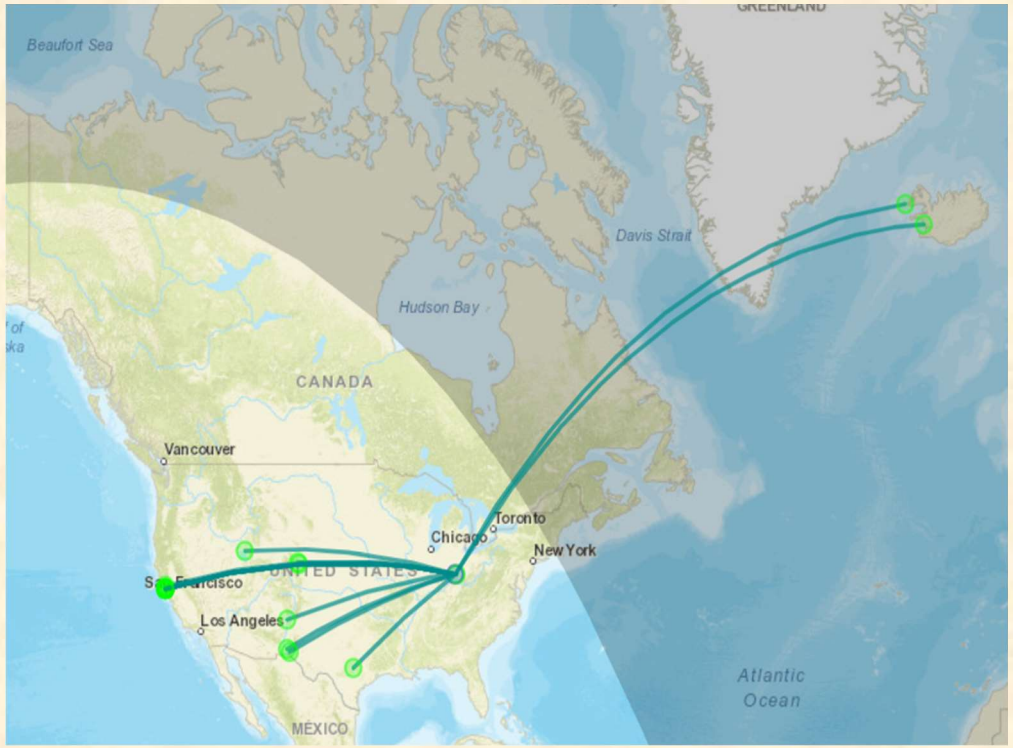


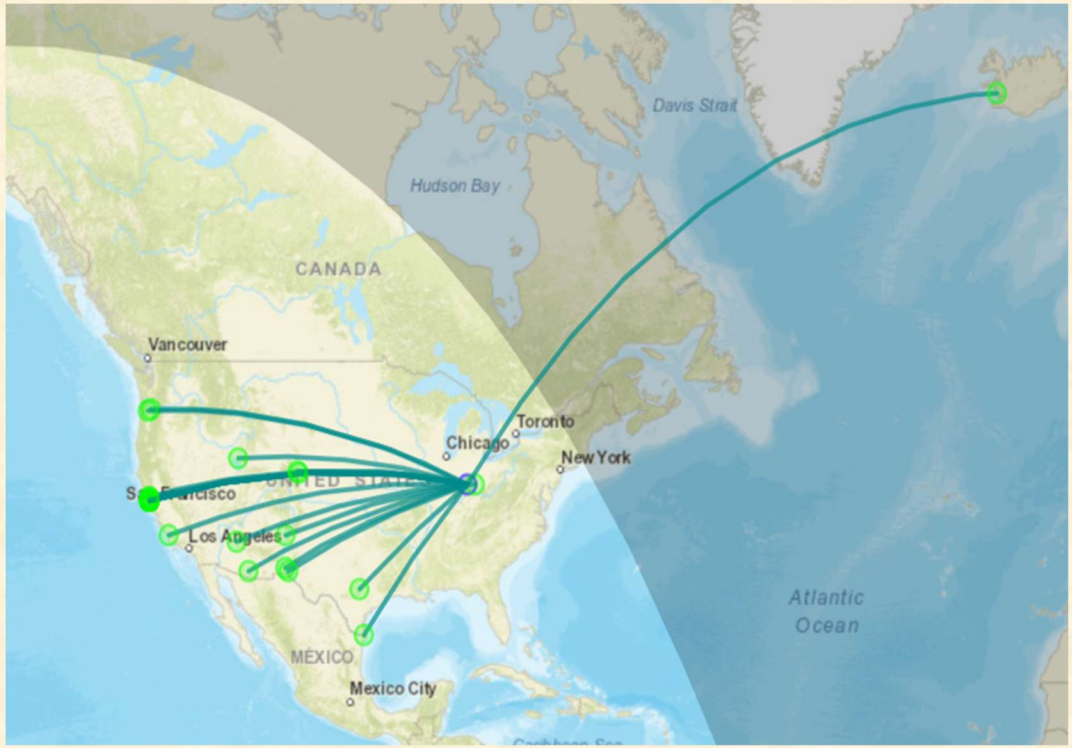
Propagation over a one hour period – 1 pm to 2 pm– Dec. 20
Beam on the left – Rhombic on the right



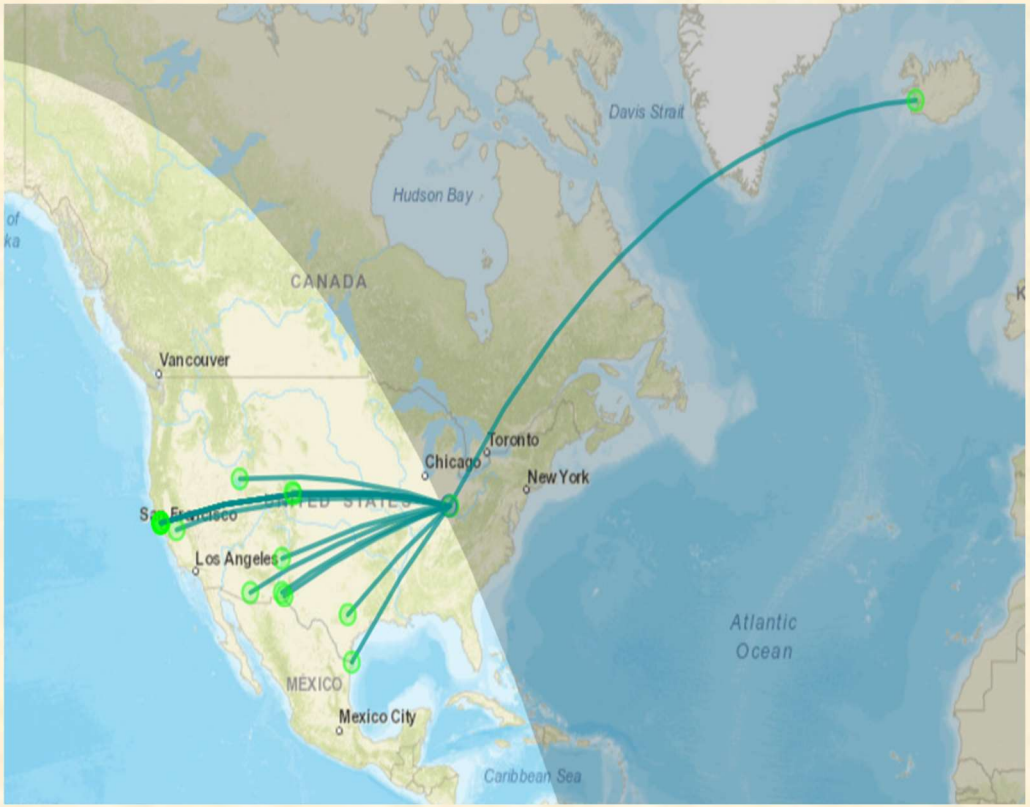


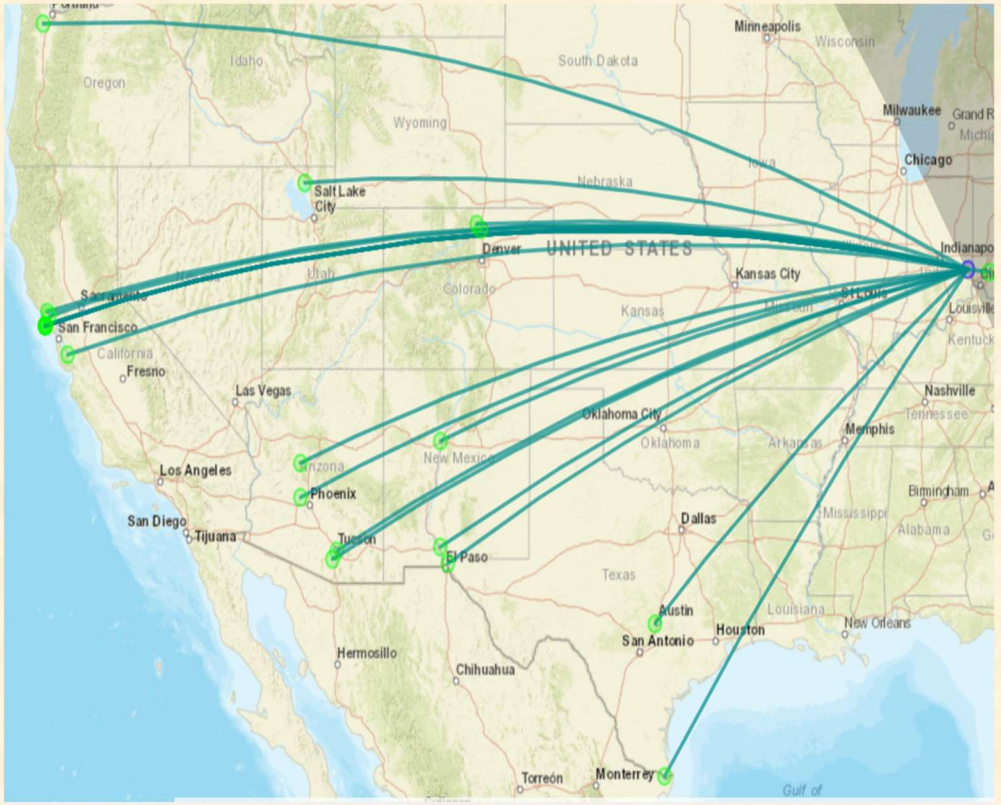
Propagation over a one hour period – 3 pm to 4 pm– Dec. 20
Beam on the left – Rhombic on the right



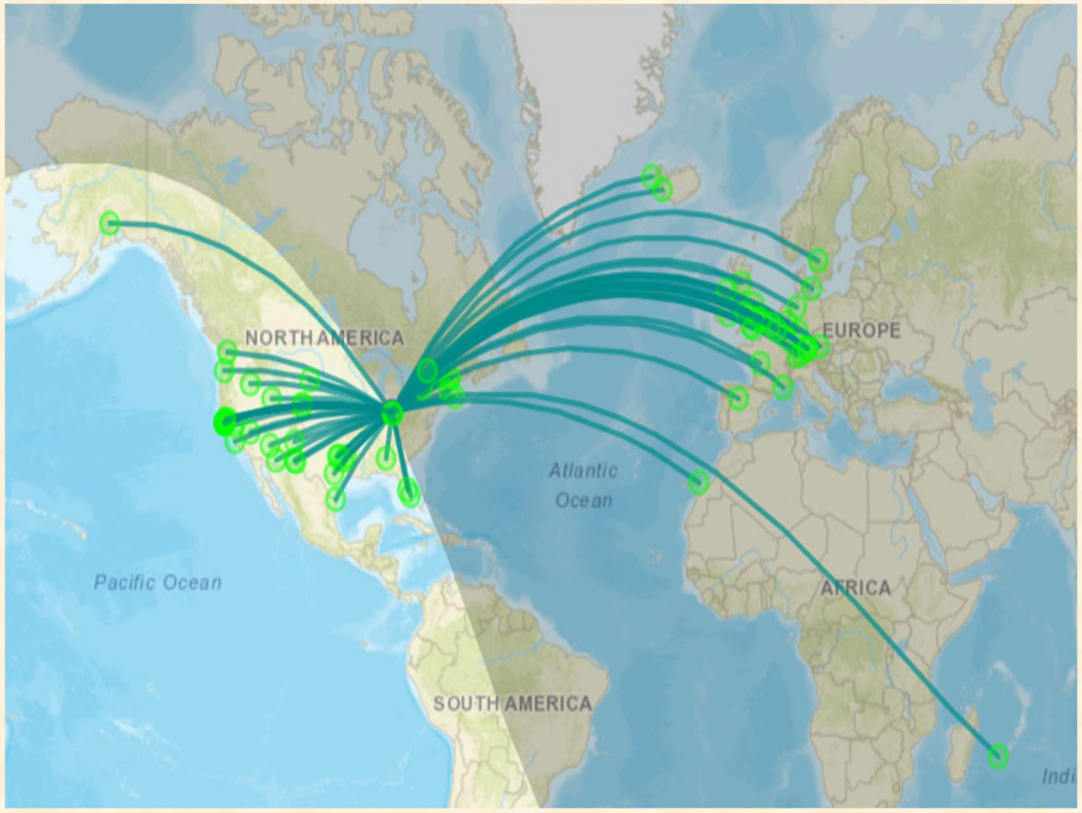


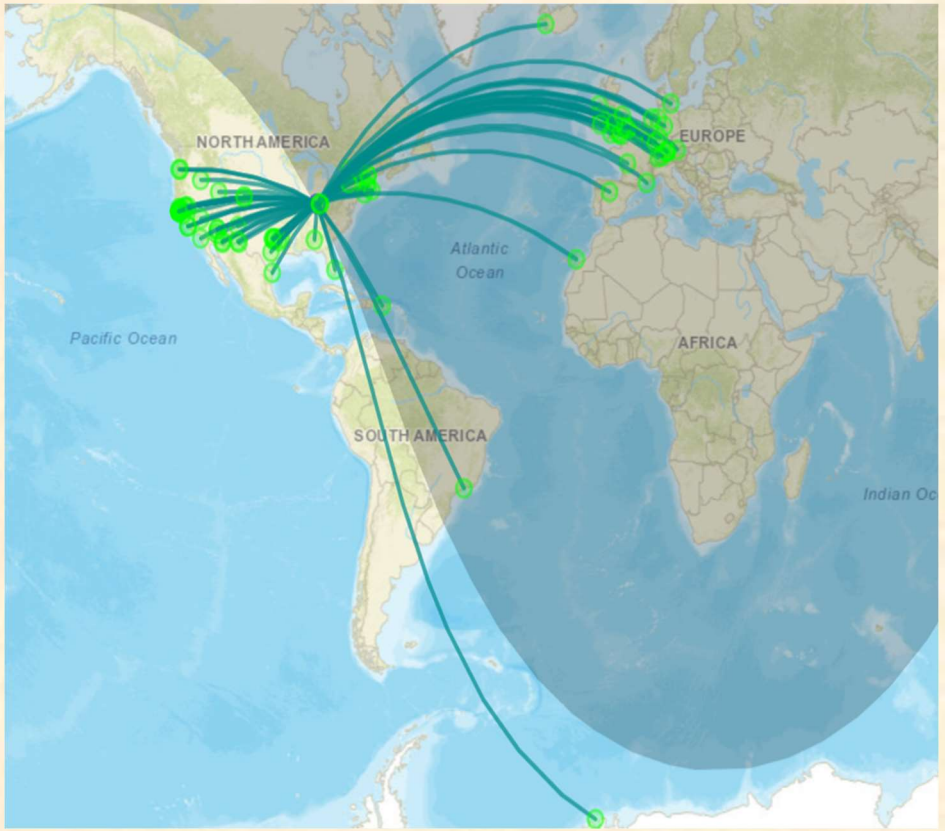
Propagation over a one hour period – 4 pm to 5 pm– Dec. 20
Beam on the left – Rhombic on the right





Propagation over the 24 hour period
showing all reception reports
Beam on the left - Rhombic on the right

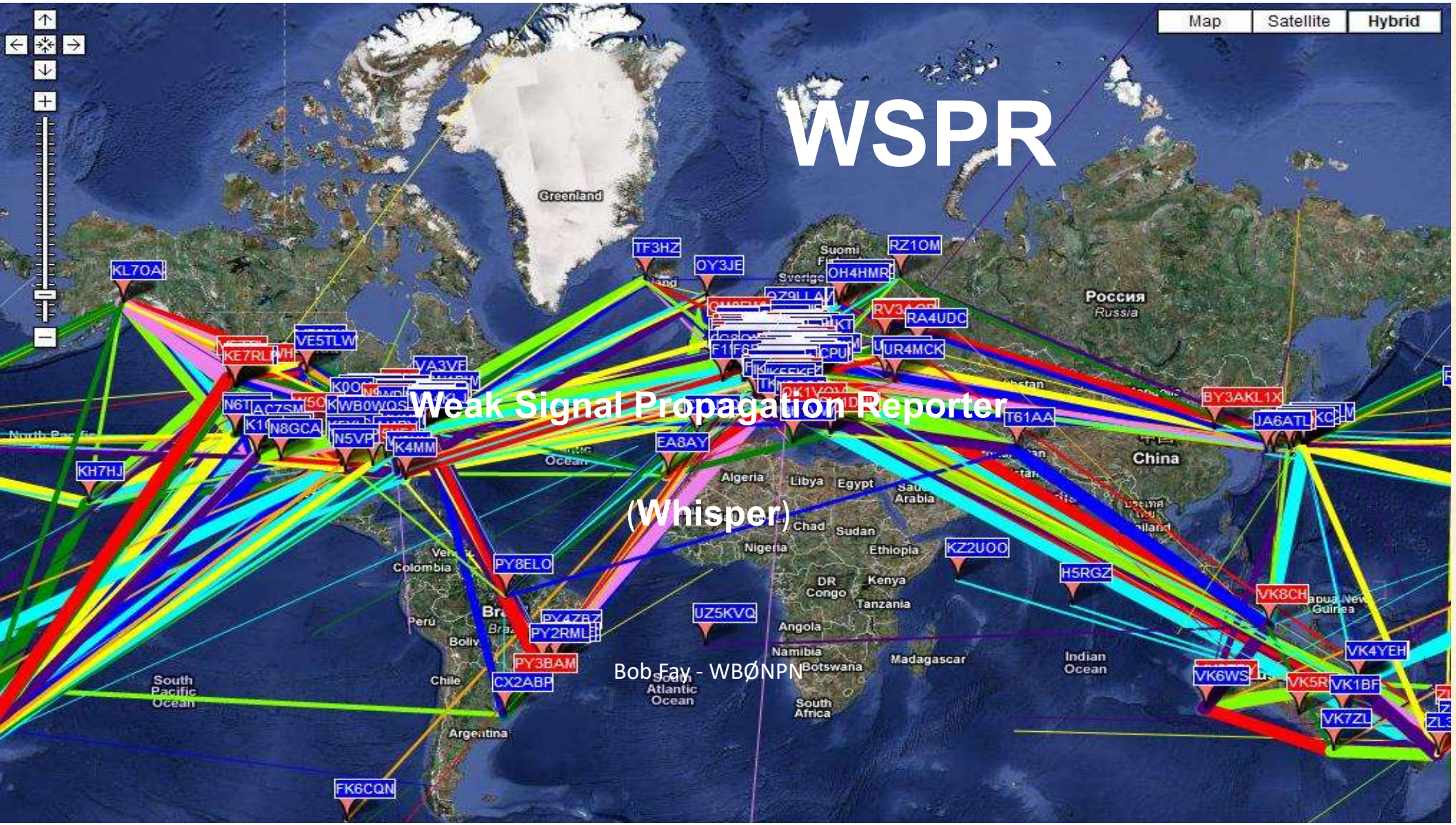




WSPR Tutorial

- www.g4ilo.com/wspr.html

- **Covers theory, operation, and equipment setup**


WSPR
Weak Signal Propagation Reporter
(Whisper)
Bob Fay - WBØNPN
Map
Satellite
Hybrid
Greenland
Россия
Russia
China
Suomi
Sverige
Algeria
Libya
Egypt
Chad
Sudan
Nigeria
Ethiopia
Kenya
Tanzania
Angola
Namibia
Botswana
Madagascar
South Africa
Indian Ocean
South Pacific Ocean
Chile
Argentina
Peru
Colombia
Papua New Guinea
KL7OA
VE5TLW
KE7RL
N8GCA
N5VP
K4MM
KH7HJ
TF3HZ
OY3JE
OH4HMR
RZ1OM
RA4UDC
UR4MCK
EA8AY
T61AA
BY3AKL1X
JA6ATL
KZ2UOO
H5RGZ
VK8CH
VK4YEH
VK6WS
VK5R
VK1BF
VK7ZL
PY8ELO
PY2RML
PY3BAM
CX2ABP
UZ5KVQ
FK6CQN