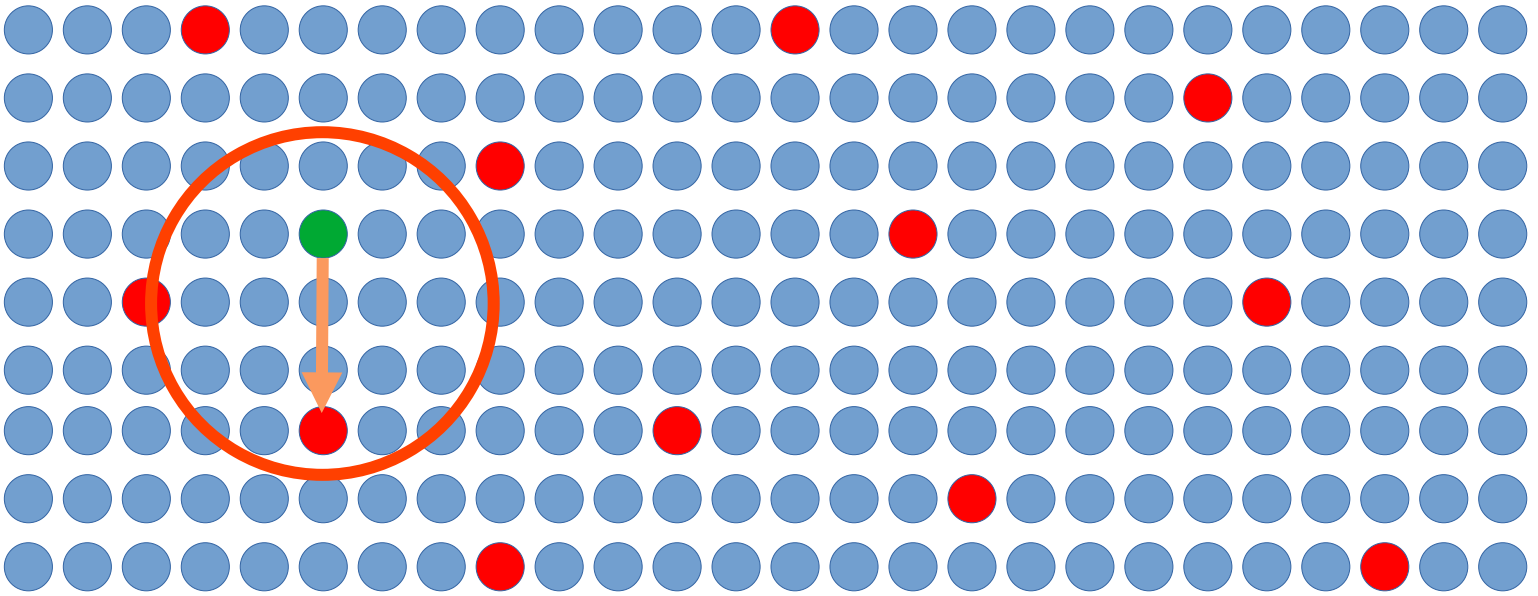
Using WSPR to Find Open Bands

- What is WSPR?
  - Side journey into error-control coding
- WSPR Transmitter & Antenna
- Caveats
- WSPR Mid-Afternoon
- WSPR During Grayline
- WSPR at Night

How the Magic Works

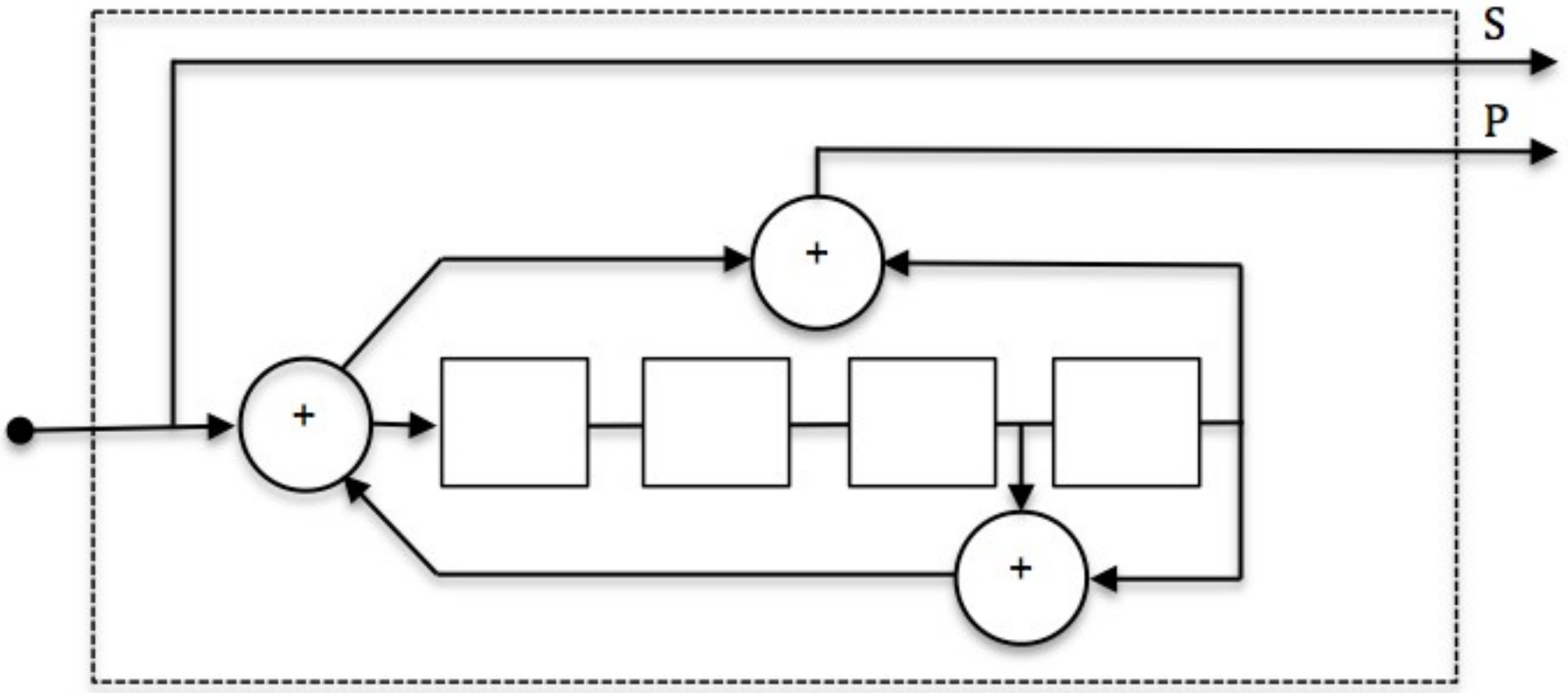
- Automatic Repeat reQuest (ARQ)
  - Some parity bits are computed and attached to the message
  - Upon receipt, parity bits recomputed
  - If they differ from what was received, a Repeat is reQuested, otherwise an ACKnowledgement is sent
  - This is how the Internet works (TCP)
- Forward Error Correction (FEC)
  - More parity bits are computed and attached to the message
    - Sometimes parity bits can outnumber the message bits
  - Upon receipt, parity bits recomputed
  - If they differ from what was received, the receiver looks for the “closest” symbol
- Gazillion ways to implement this

Distance Metric



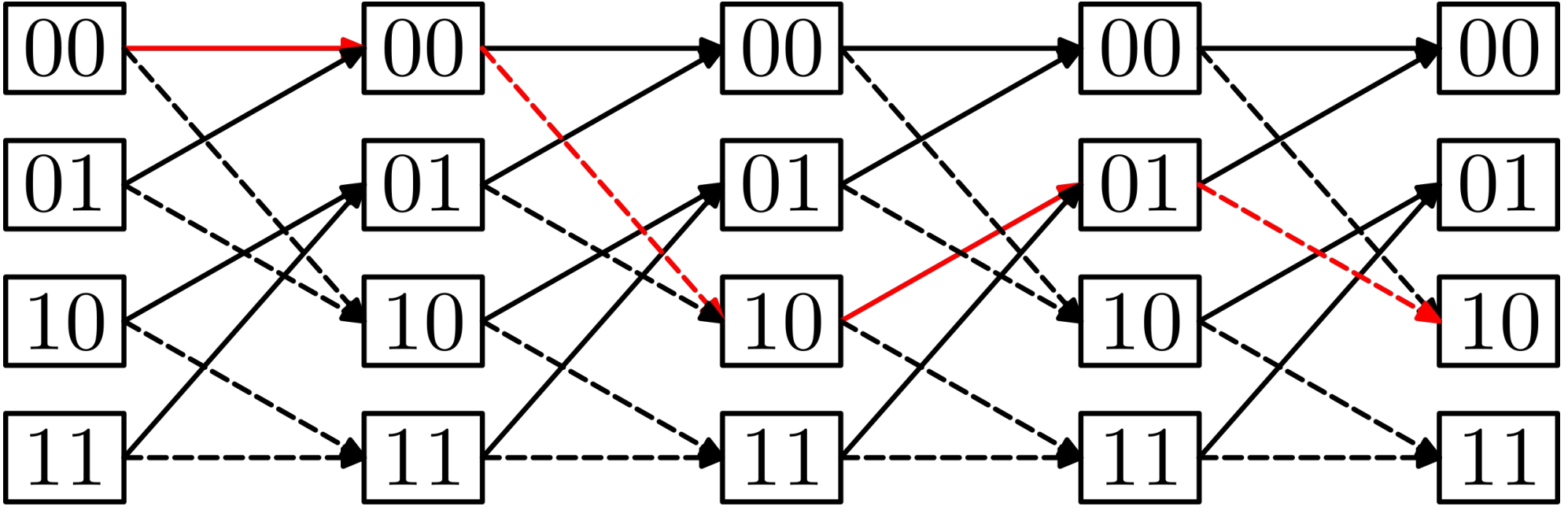
If too many errors, this method can pick the wrong answer

Convolutional Coder Example



Sixteen state recursive systematic convolutional code

Trellis (Viterbi) Decoder Example



Weak Signal Propagation Reporter

1. Transmitted message: callsign + 4-character-locator + dBm Example: "K1JT FN20 30"

2. Message length after lossless compression: 28 bits for callsign, 15 for locator, 7 for power level ==> 50 bits total.

3. Forward error correction (FEC): long-constraint convolutional code, K=32, r=1/2.

4. Number of channel symbols: nsym = (50+K-1)*2 = 162.

Weak Signal Propagation Reporter

5. Keying rate: 12000/8192 = 1.46 baud.

6. Modulation: continuous phase 4-FSK. Tone separation 1.46 Hz.

7. Synchronization: 162-bit pseudo-random sync vector.

8. Data structure: each channel symbol conveys one sync bit and one data bit.

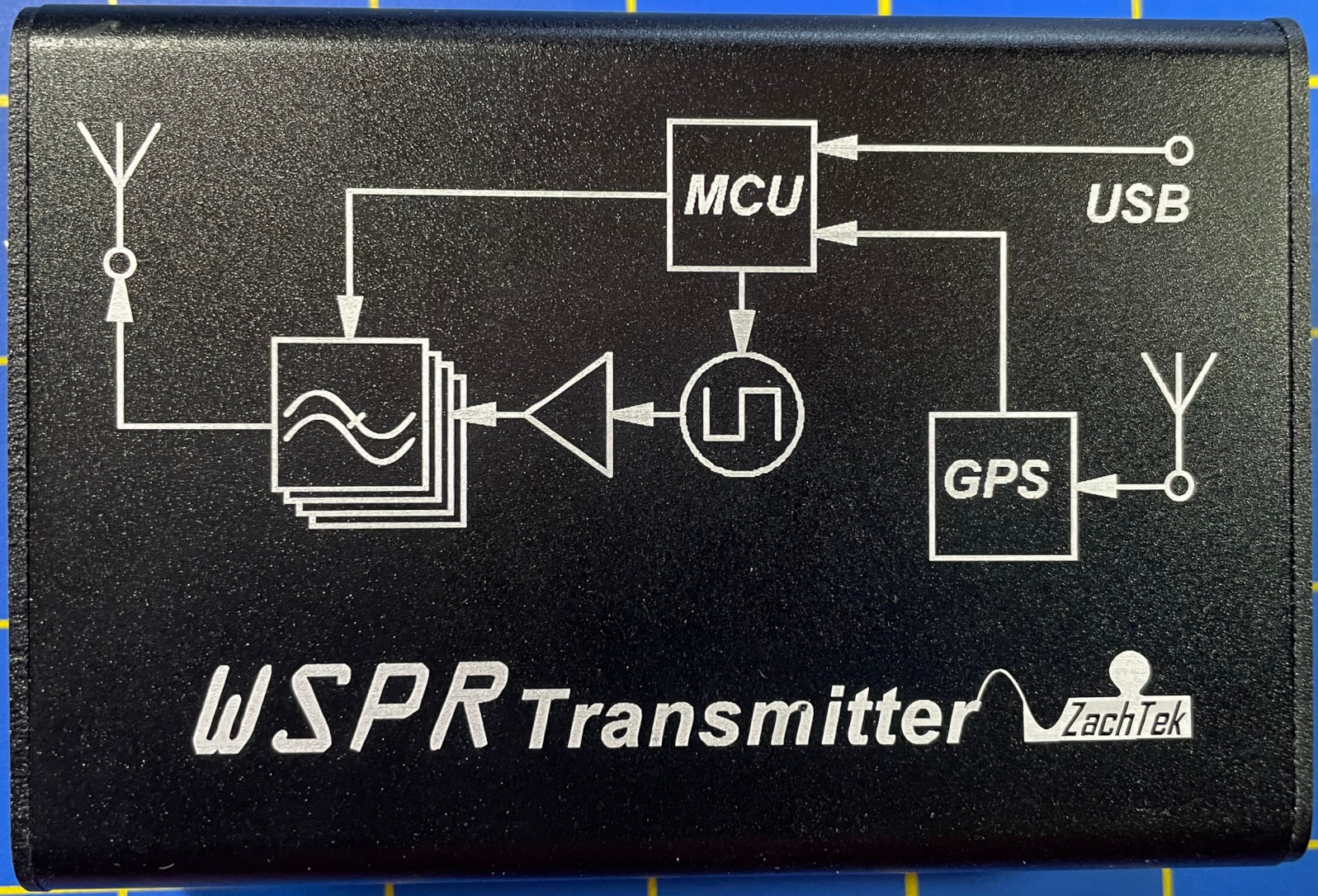
Weak Signal Propagation Reporter

9. Duration of transmission: 162*8192/12000 = 110.6 s.

10. Transmissions start two seconds into an even UTC minute: i.e., at hh:00:02, hh:02:02, ...

11. Occupied bandwidth: about 6 Hz

12. Minimum S/N for reception: around -27 dB on the WSJT scale (2500 Hz reference bandwidth).


MCU
USB
GPS
WSPR Transmitter
ZachTek


WSPR Desktop Transmitter
ProdNo: 1012
HW Version: 2.38
5V 300mA
Handmade in Sweden
Model: 80To10
https://www.zachtek.com/1012


Transmitter Output
TX
IN
SHIELD


GPS
Antenna
Status
Pwr
USB
IN
OUT
SHIELD
Model: ANT-1500
GND
Patented

ZachTek WSPR Transmitter Configuration Version 1 - Revision 16

Device name

WSPR KE0OG

WSPR Beacon | Signal Generator | Boot Configuration | Serial Port

WSPR Configuration

Call Sign

Prefix | Call Sign | Suffix

KE0OG

Band selection

LP	Band	Progress
	2190m	
	630m	
	160m	
	80m	
	40m	
	30m	
	20m	
	17m	
	15m	
	12m	
	10m	
	6m	
	4m	

Pause after last band (optional).

0

Transmit Schedule, transmit every ..

- 2 minutes (Default)
- 10 minutes
- 20 minutes
- Band coordinated schedule
- Only when moving (Tracker)

Schedule

Location

- Auto (GPS)
- Manual DM68

Send a more precise location

Reported power

- Normal mode 23 dBm
- Encode Altitude as power

Start | Stop

Device Status

Hardware 2 : 38

Firmware 2 : 18

Restart

Current output frequency

18 106 031.92

MHz kHz Hz

Transmitter Output

- On
- Off

Program running

- WSPR Beacon
- Signal Generator
- Idle

GPS Information

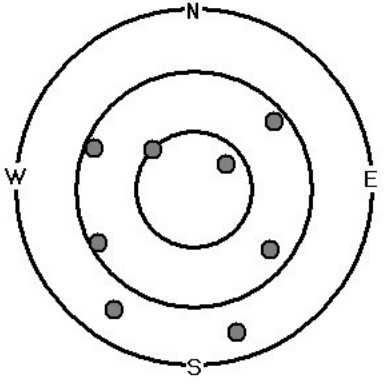
Signal Quality

14%

Position Lock

UTC Time	Position
21:34:00	DM68CG

Az/El plot of GPS Satellites



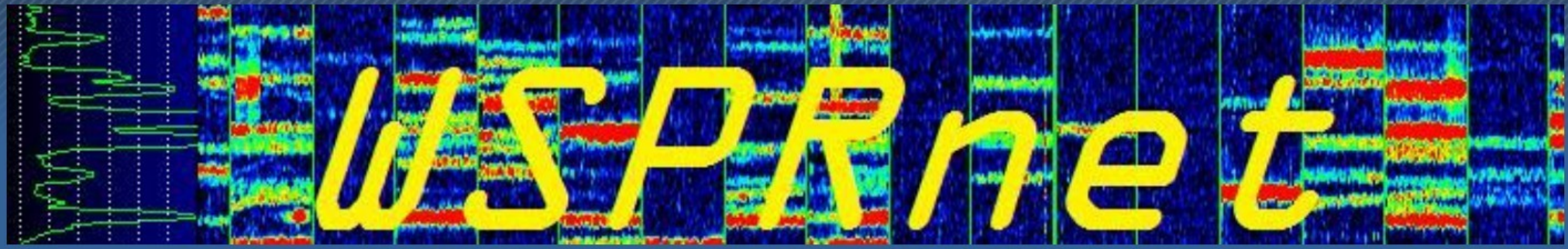

```
ZachTek WSPR Desktop transmitter
Firmware version 2:18
```

Debug view

Read progress 100%

(Re)Read Settings

Save Settings



WSPRnet

Welcome to the Weak Signal Propagation Reporter Network

Search

Chat | Activity | Map | Database | Forum | Downloads

My account | Log out

Frequencies

USB dial (MHz): 0.136, 0.4742, 1.8366, 3.5686, 5.2872, 5.3647, 7.0386, 10.1387, 13.5539, 14.0956, 18.1046, 21.0946, 24.9246, 28.1246, 50.293, 70.091, 144.489, 432.300, 1296.500

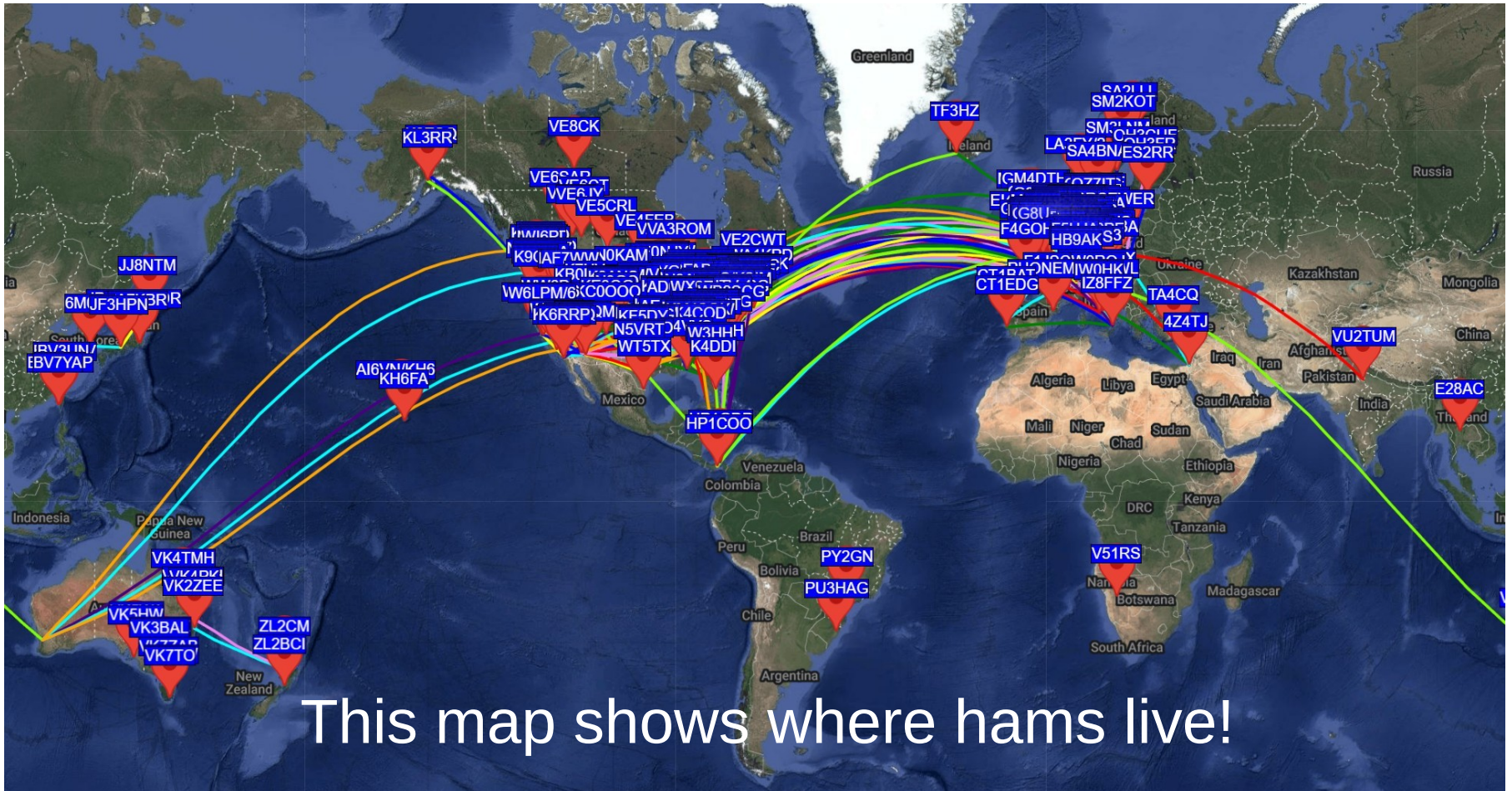
Navigation

The Weak Signal Propagation Reporter Network is a group of amateur radio operators using K1JT's MEPT_JT digital mode to probe radio frequency propagation conditions using very low power (QRP/QRPp) transmissions. The software is open source, and the data collected are available to the public through this site.

WSPRnet bulk upload limits

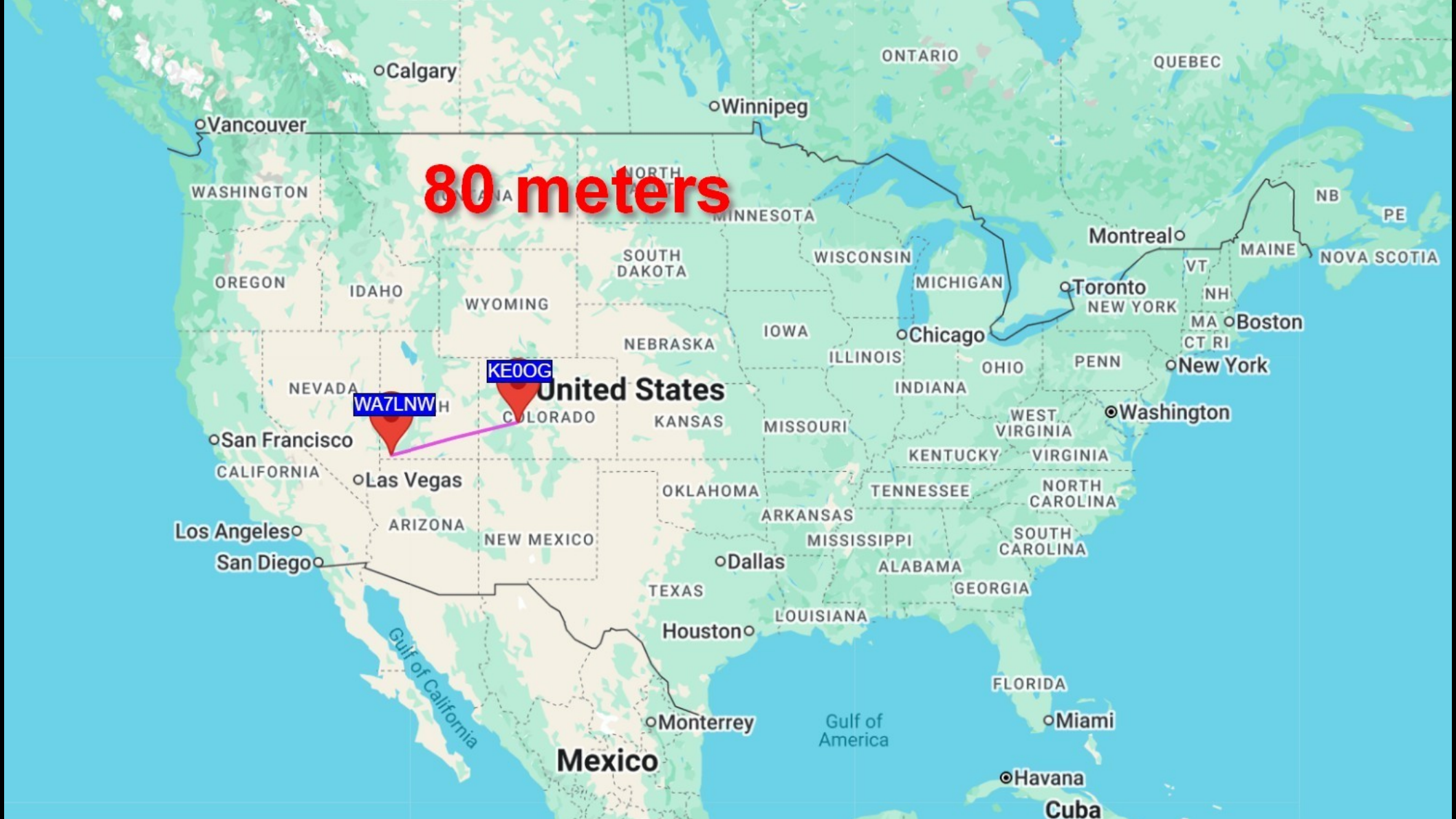
Starting about 2.5 days ago, the load on the WSPRnet database went critical. It appears this was caused by many stations bulk-uploading spots over and over again, almost all of which were already in the database. A similar problem last year caused me to implement

The Great WSPR Caveat



Mid-Afternoon

- ~ 2:30 MDT, 2030 UTC
- Grid Square DM68cg (20 miles SE of Montrose)
- Data taken 19 July 2025


80 meters
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WA7LNW
Calgary
Vancouver
Winnipeg
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QUEBEC
Montreal
Toronto
Chicago
Boston
New York
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San Francisco
Las Vegas
Los Angeles
San Diego
Dallas
Houston
Monterrey
Mexico
Miami
Havana
Cuba
Gulf of California
Gulf of America
WASHINGTON
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TENNESSEE
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FLORIDA
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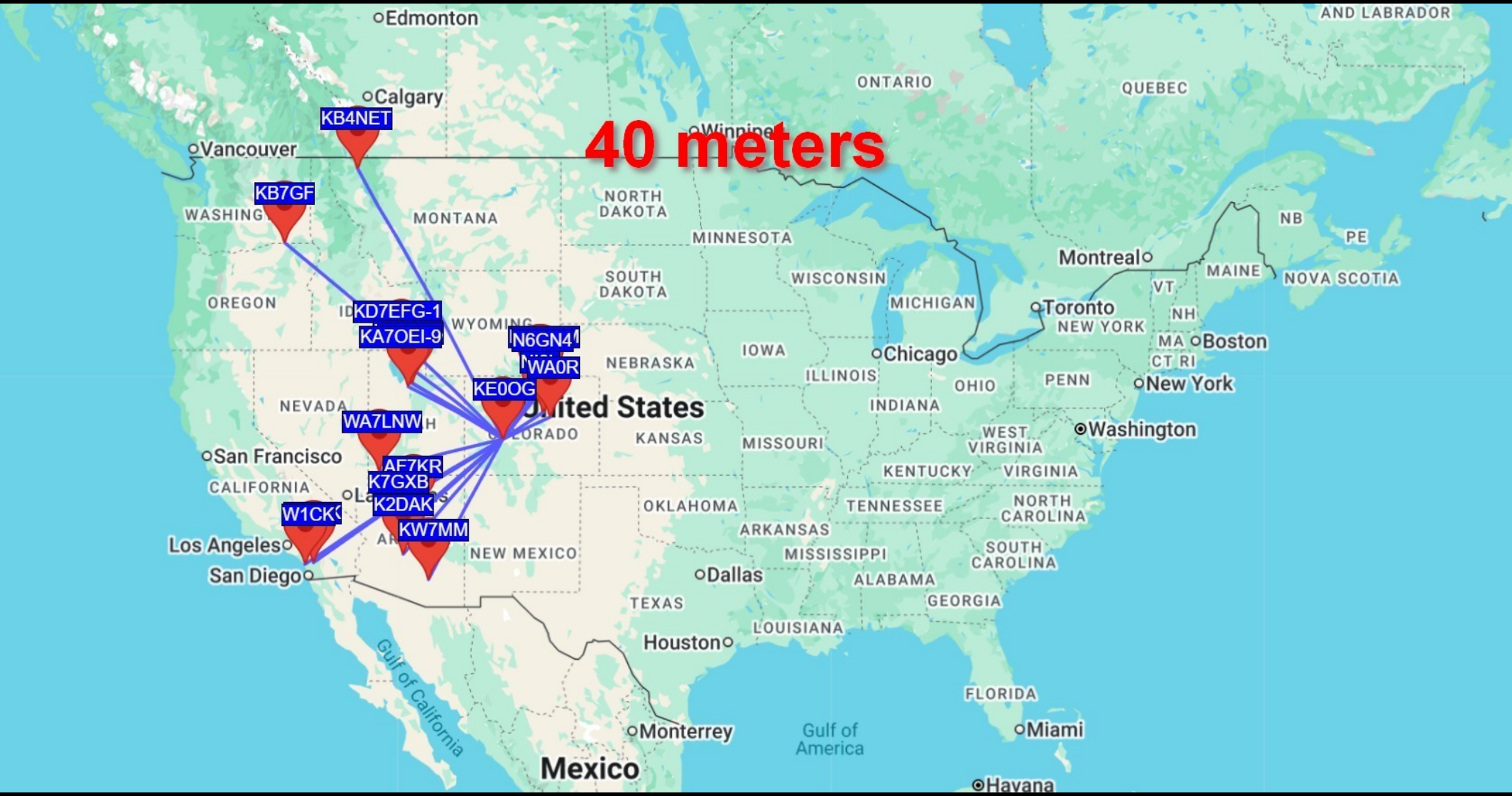
CT RI
NB
PE
NOVA SCOTIA
United States


40 meters
KB4NET
KB7GF
KD7EFG-1
KA7OEI-9
N6GN4
WA0R
KE0OG
WA7LNW
AF7KR
K7GXB
K2DAK
W1CK
KW7MM
Edmonton
Calgary
Vancouver
Winnipeg
ONTARIO
QUEBEC
AND LABRADOR
WASHING
MONTANA
NORTH DAKOTA
MINNESOTA
SOUTH DAKOTA
WISCONSIN
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Miami
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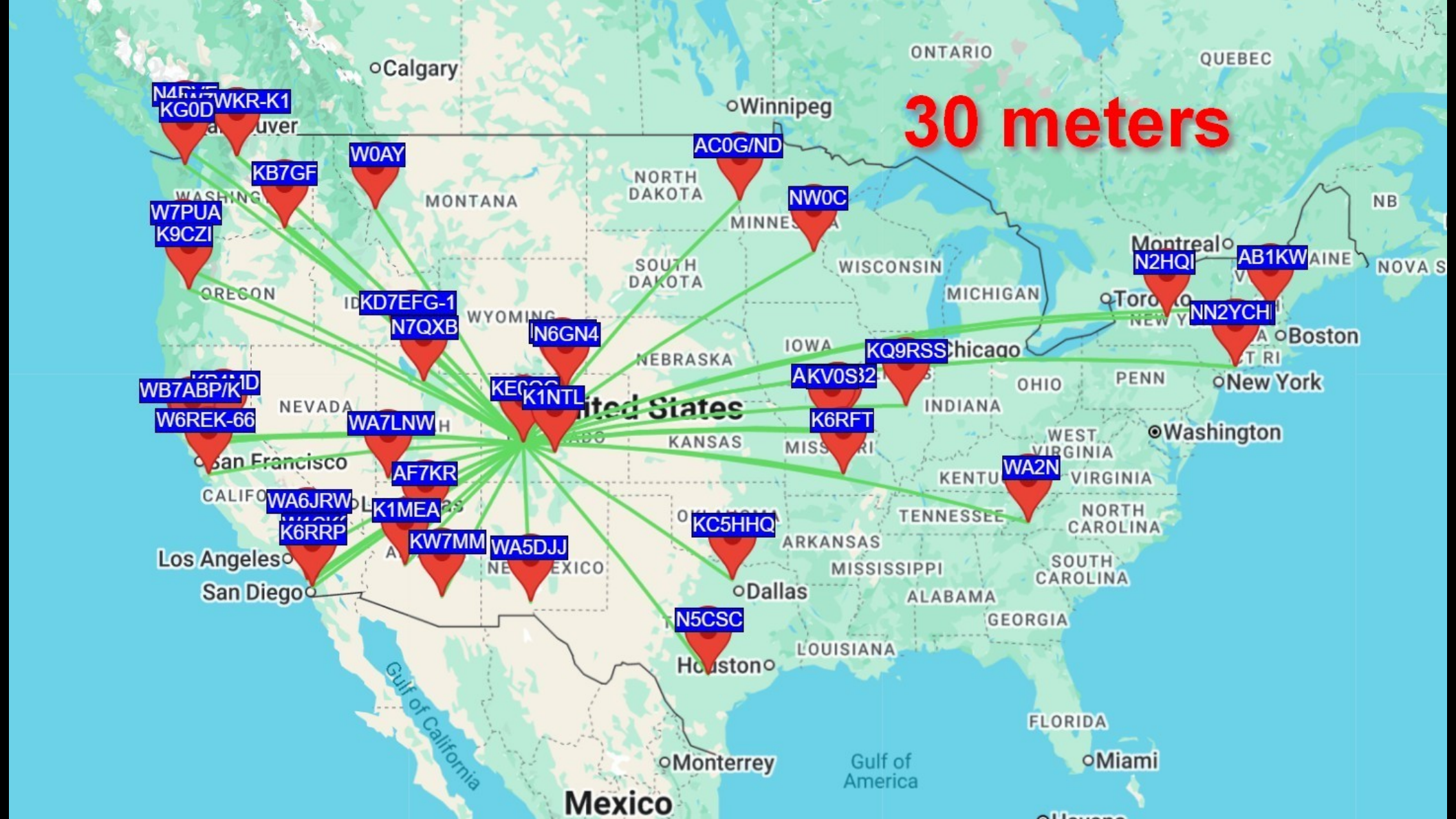
Havana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W0AY
KB7GF
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K9CZI
AC0G/ND
NW0C
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N7QXB
N6GN4
K1NTL
WB7ABP/K
W6REK-66
WA7LNW
AF7KR
WA6JRW
K1MEA
K6RRP
KW7MM
WA5DJJ
KC5HHQ
N5CSC
KQ9RSS
AKV0S
K6RFT
WA2N
N2HQI
AB1KW
NN2YCH
Calgary
Winnipeg
Montreal
Toronto
Boston
New York
Washington
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Dallas
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Los Angeles
San Diego
San Francisco
Monterrey
Miami
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Gulf of California
Gulf of America
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QUEBEC
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FLORIDA
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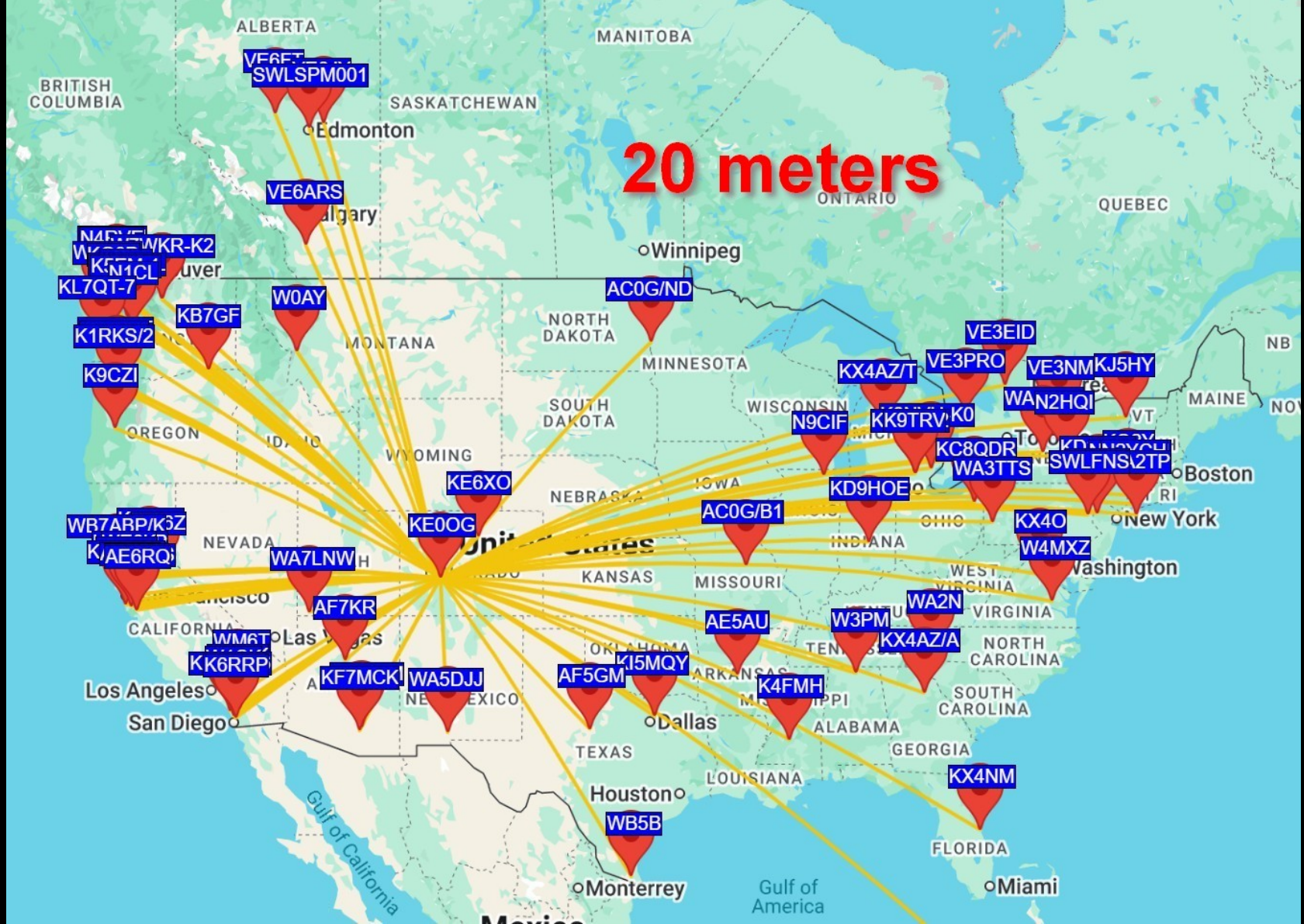
NOVA S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TEXAS
OKLAHOMA
CALIFORNIA
SWLSPM001
VE6ARS
KL7QT-7
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KB7GF
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AC0G/ND
KE6XO
KE0OG
AC0G/B1
WA7LNW
AF7KR
AE6RQ
KK6RRP
KF7MCK
WA5DJJ
AF5GM
KI5MQY
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VE3PRO
VE3NM
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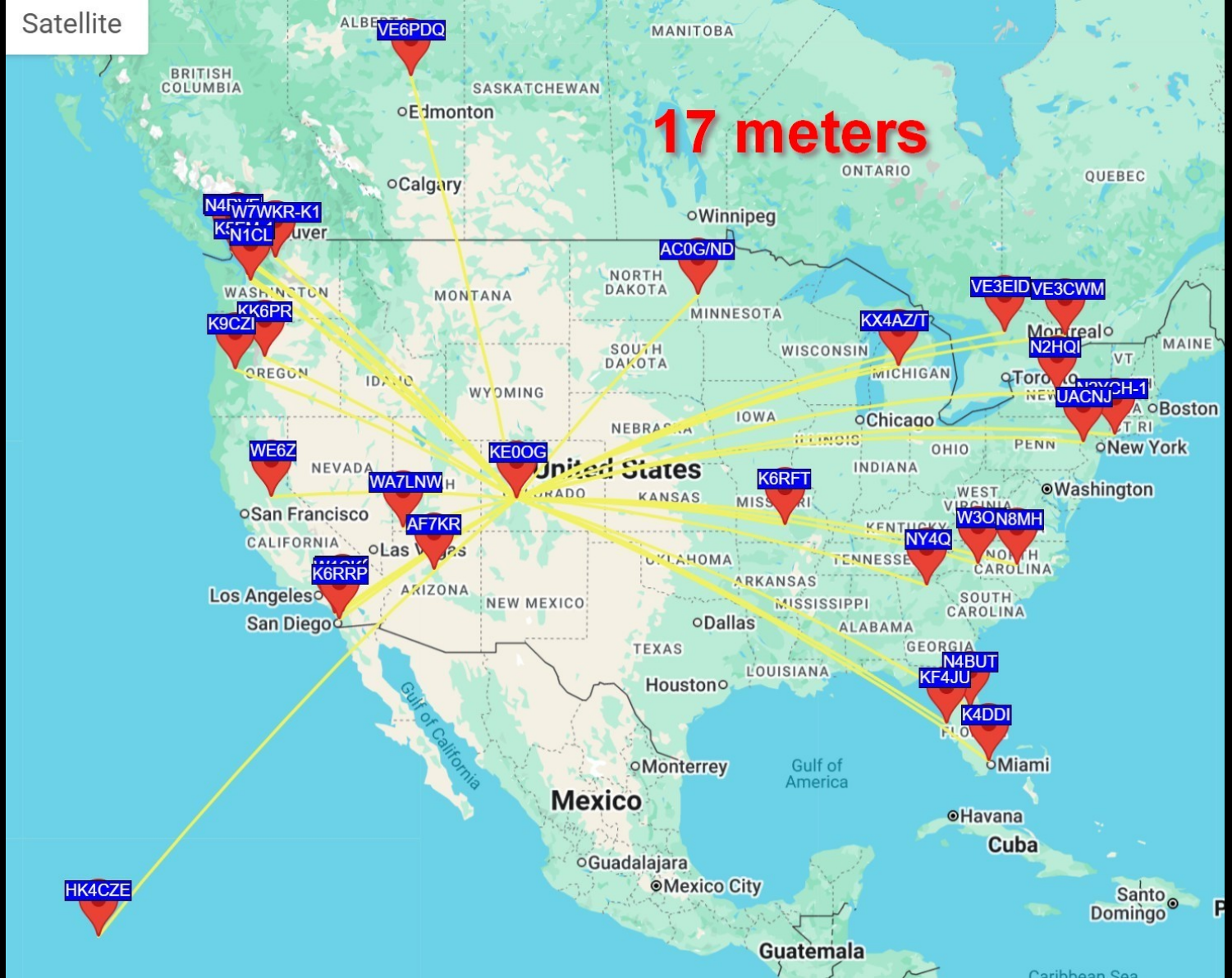
WB5B


Satellite
17 meters
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Edmonton
Calgary
Winnipeg
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N1CL
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KX4AZ/T
VE3EID
VE3CWM
N2HQI
UACNJ
WE6Z
KE0OG
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AF7KR
K6RRP
K6RFT
W3O
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KF4JU
K4DDI
HK4CZE
Chicago
New York
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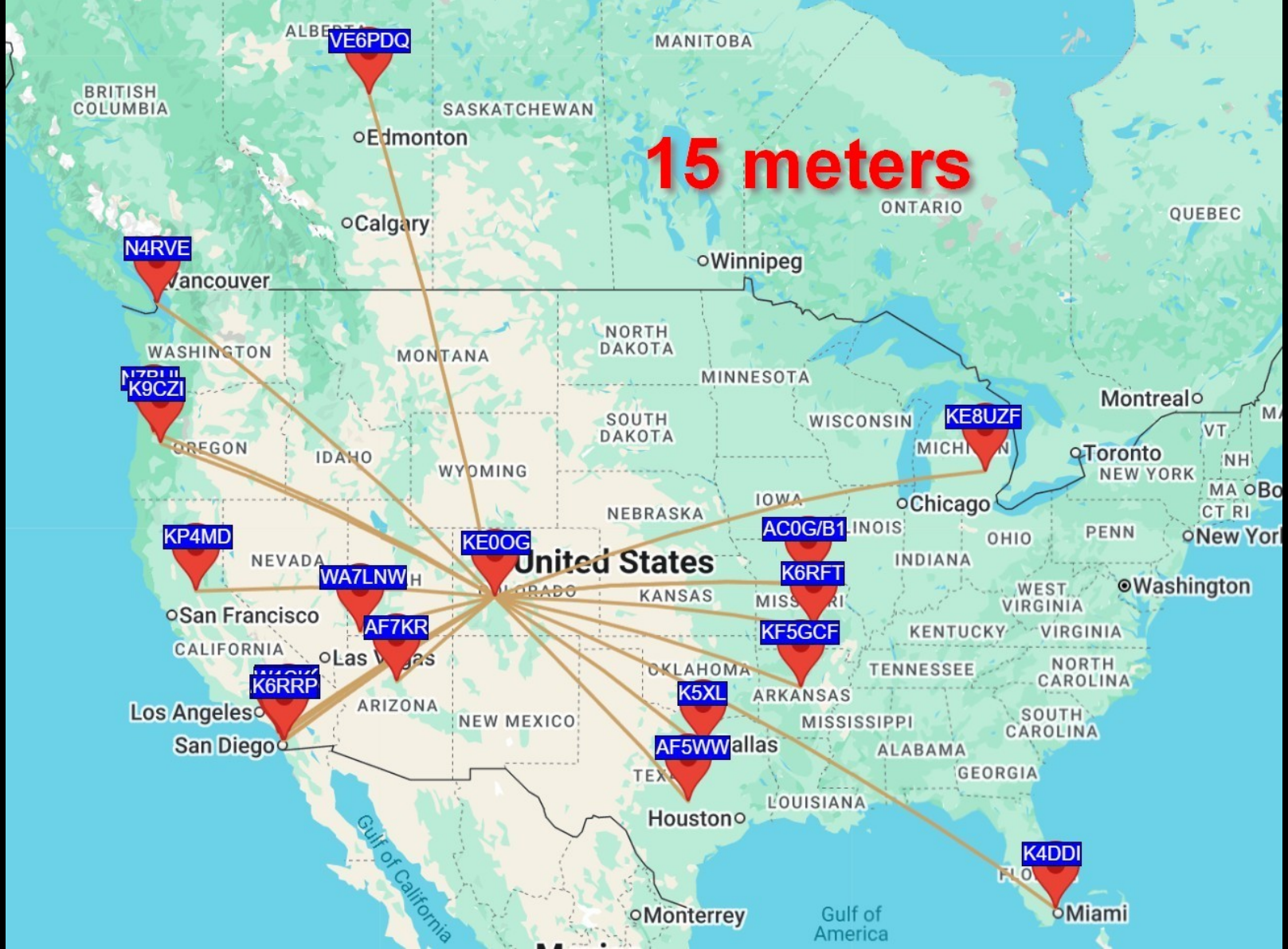
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AF7KR
K6RRP
AC0G/B1
K6RFT
KF5GCF
K5XL
AF5WW
KE8UZF
K4DDI
United States
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Vancouver
San Francisco
Los Angeles
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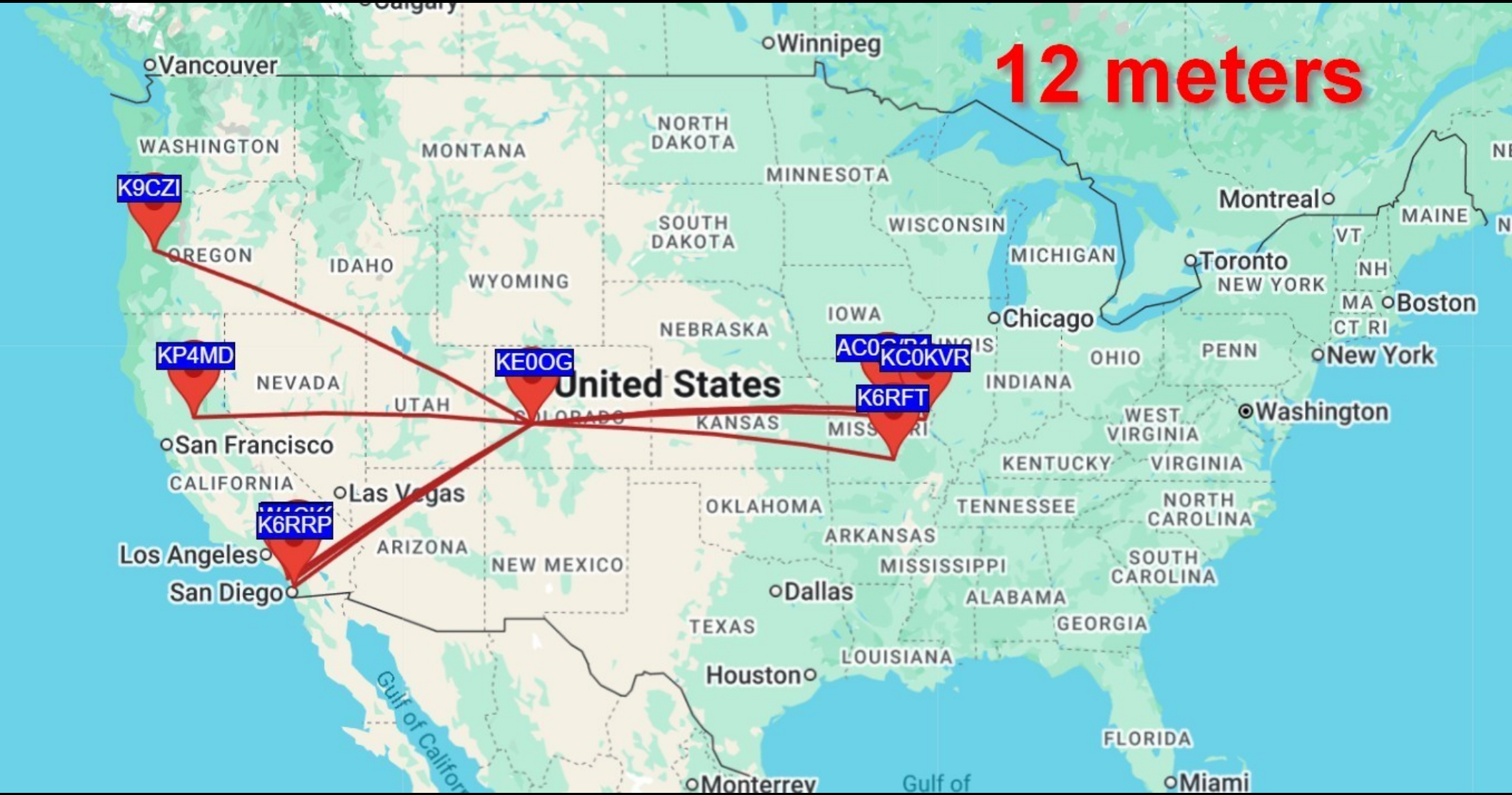
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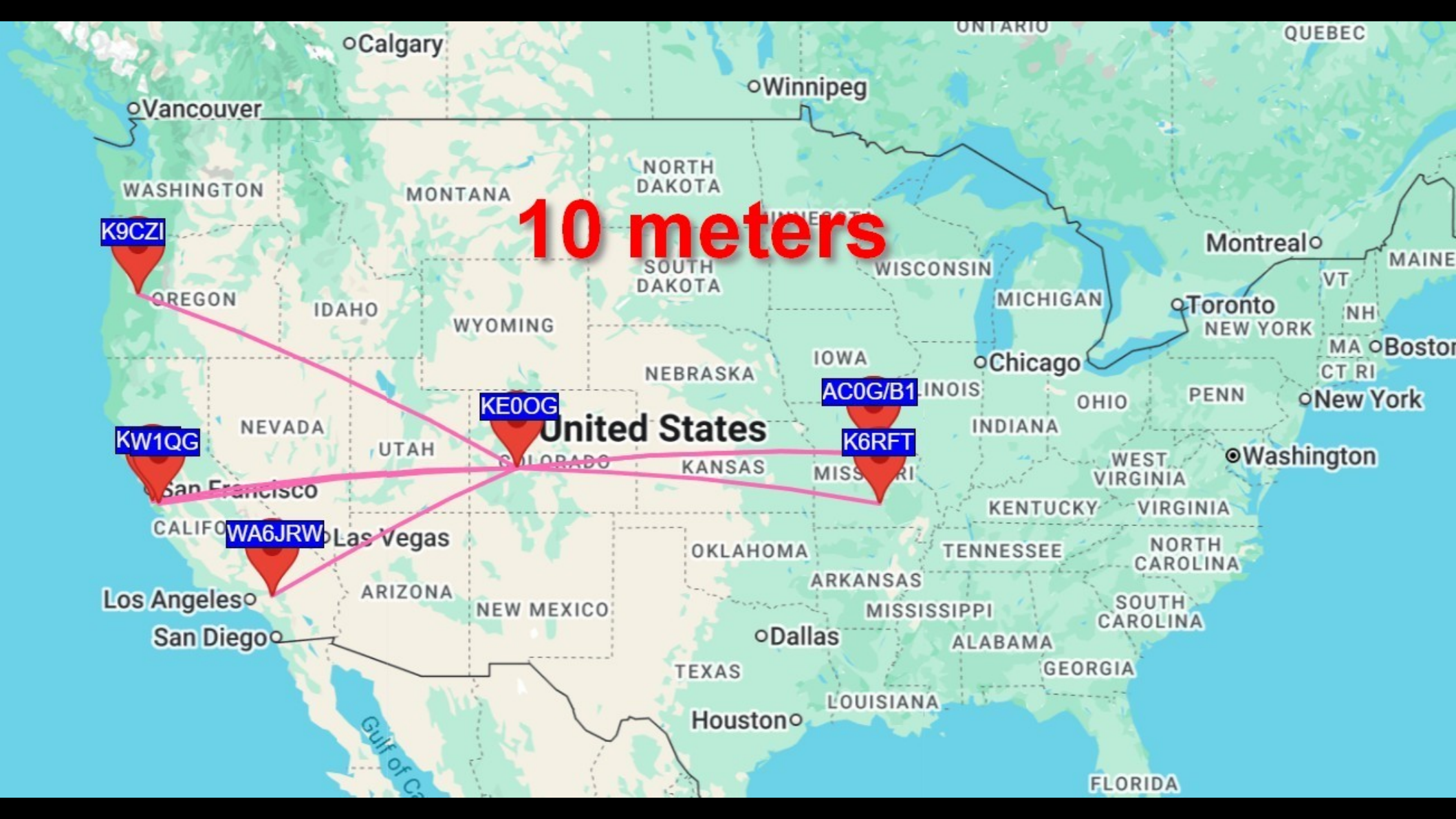
United States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KW1QG
WA6JRW
KE0OG
AC0G/B1
K6RFT
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New York
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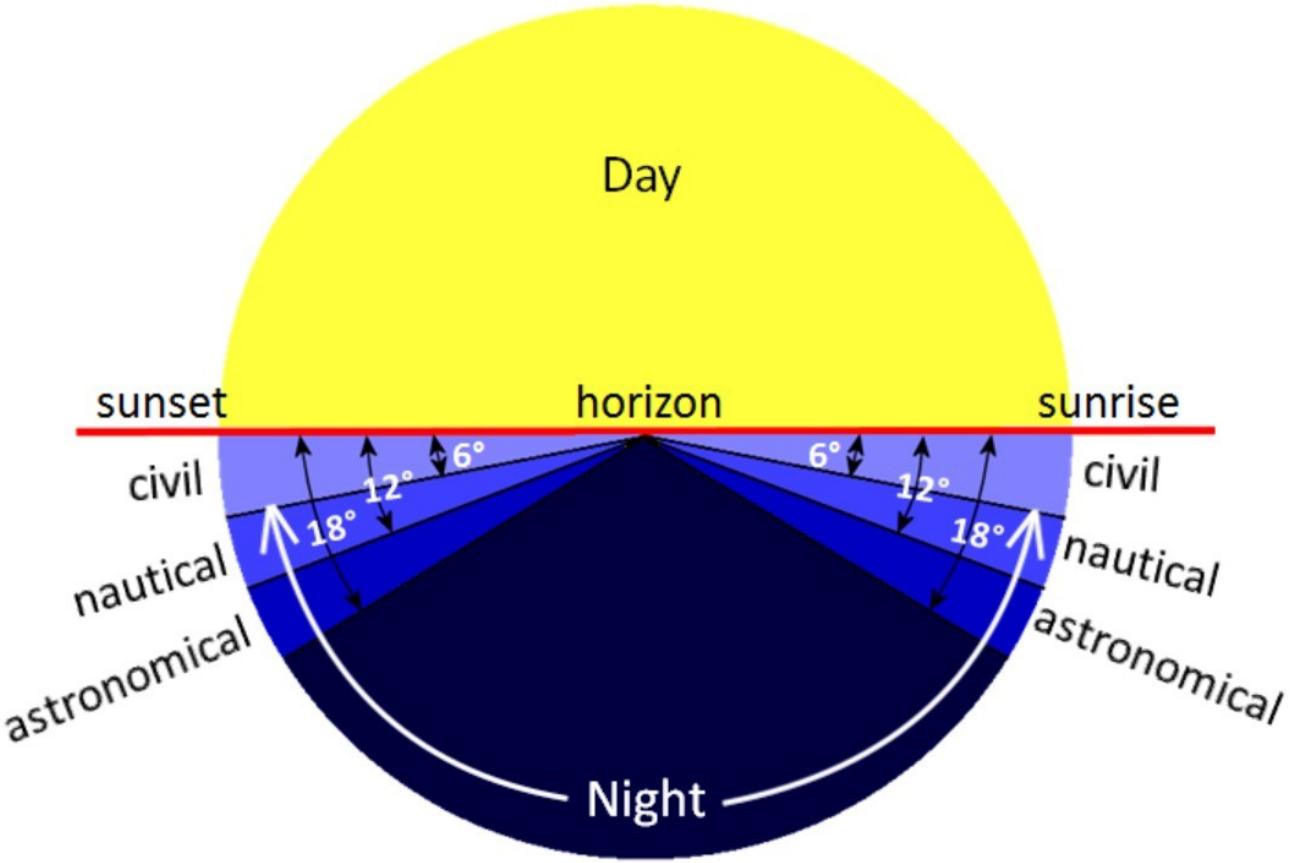
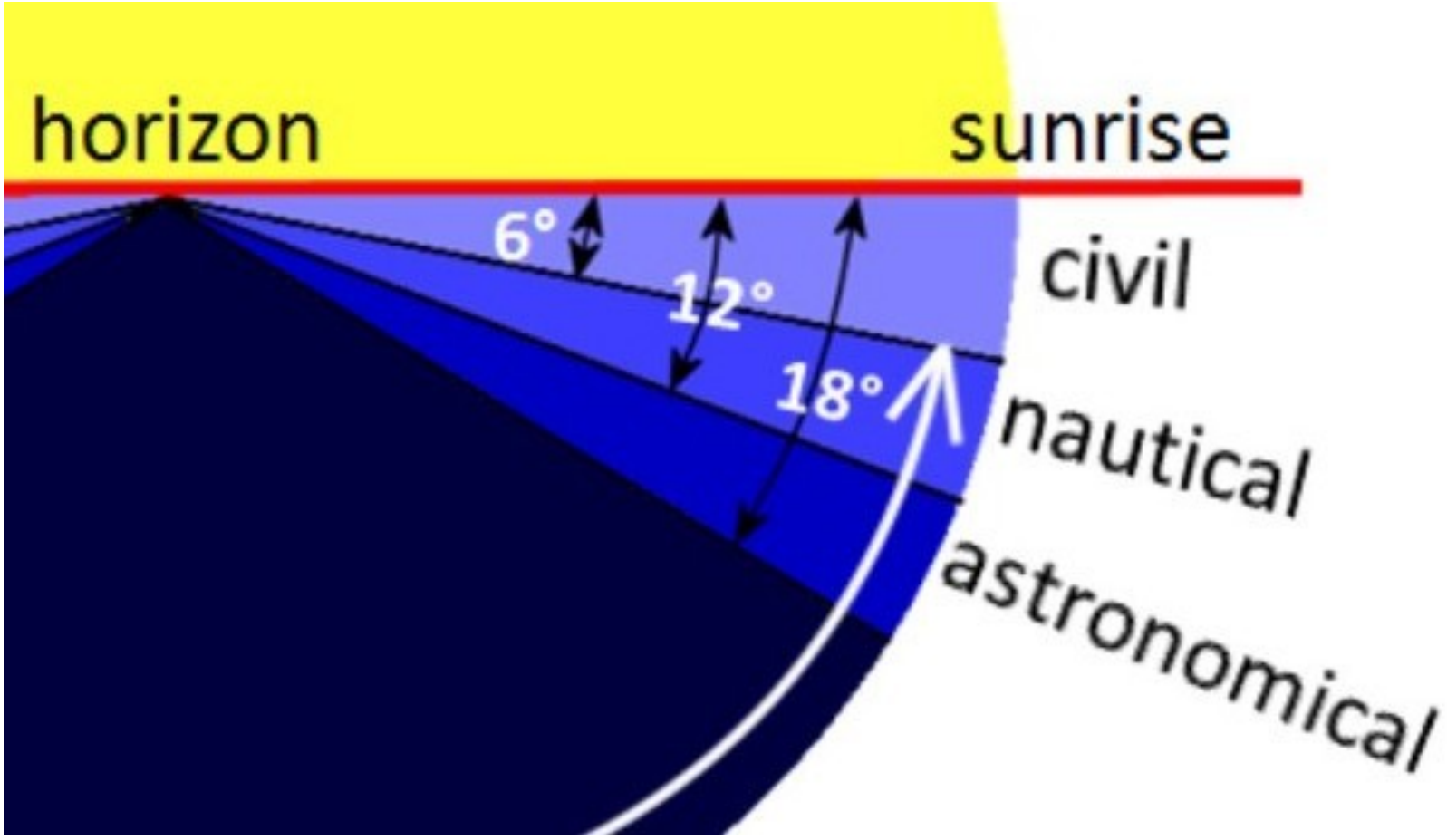
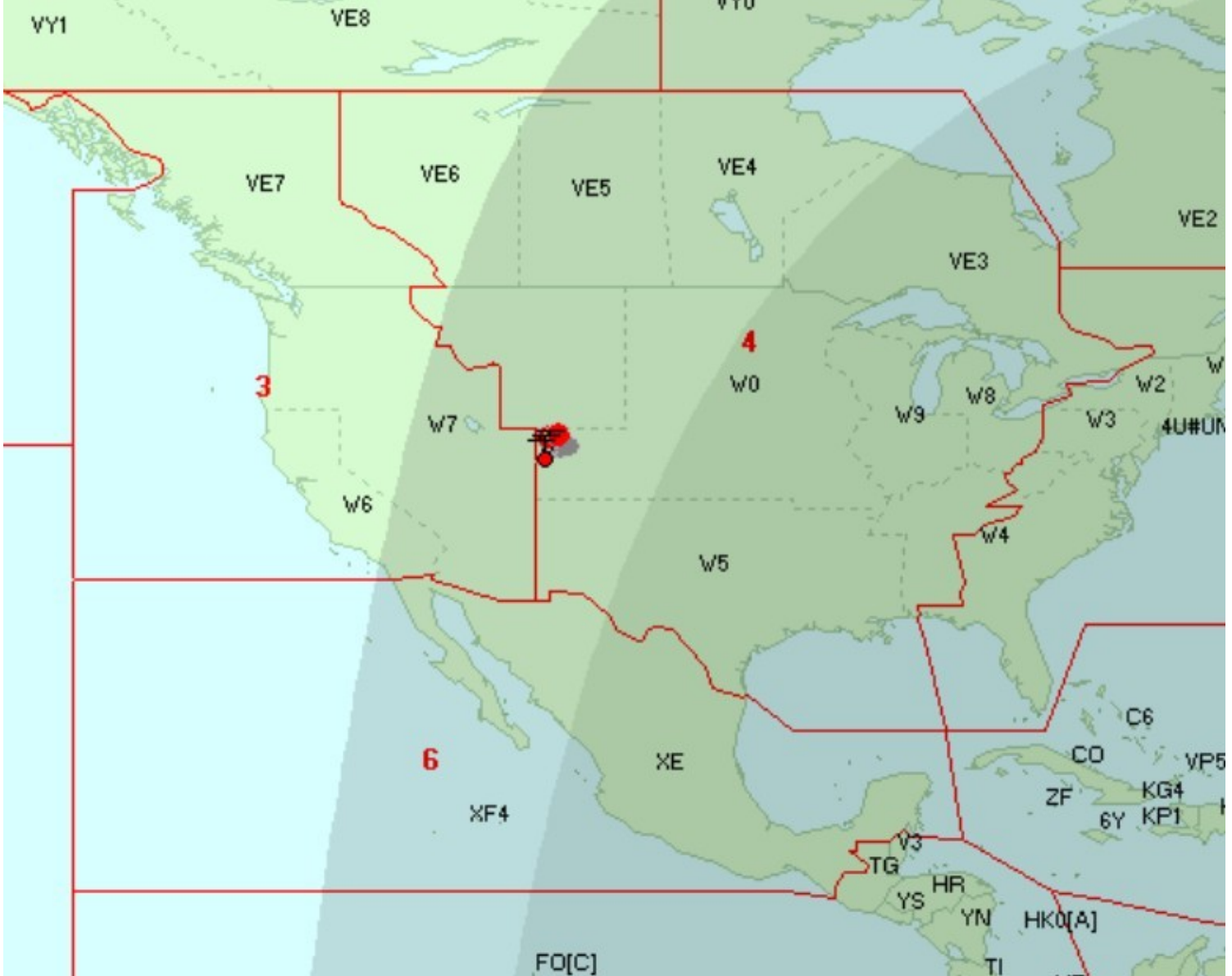
MA
CT RI
QUEBEC
ONTARIO

Grayline


Day
sunset
horizon
sunrise
civil
nautical
astronomical
6°
12°
18°
6°
12°
18°
civil
nautical
astronomical
Night

Grayline—Types of Twilight

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VE6
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VE4
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VE3
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3
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W2
W8
W9
W7
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W6
W4
W5
C6
6
XE
CO
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KP1
V3
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YS
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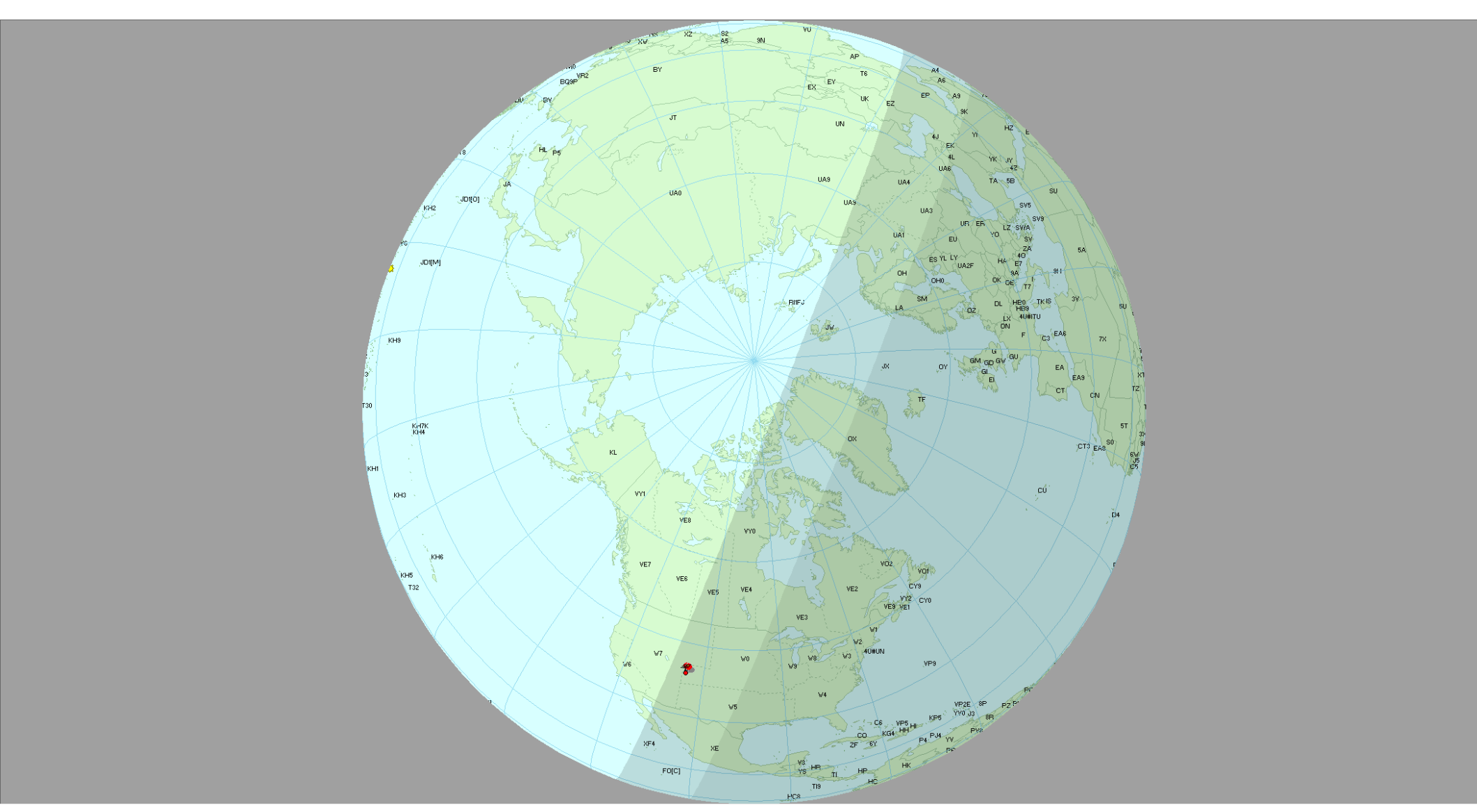
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UK
EZ
9K
JT
UN
HZ
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YI
EK
4L
HL
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JY
4Z
UA6
JA
UA9
UA4
TA
5B
SU
UA0
UA5
SV5
KH2
JD1[O]
UA3
SV9
UR
ER
LZ
SV/A
UA1
YO
EU
SV
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E7
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HE9
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C3
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KH9
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GD
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OY
EA
GI
EI
EA9
CT
CN
TF
T30
KH7K
KH4
5T
OX
KL
CT3
EA8
KH1
KH3
CU
YV1
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VY0
KH6
VE7
VO2
VO1
KH5
VE6
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VE5
VE4
VE2
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VE9
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VE3
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W5
VP2E
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J3
8R
KP5
C6
VP5
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HI
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CO
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PJ4
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ZF
6Y
XF4
XE
V3
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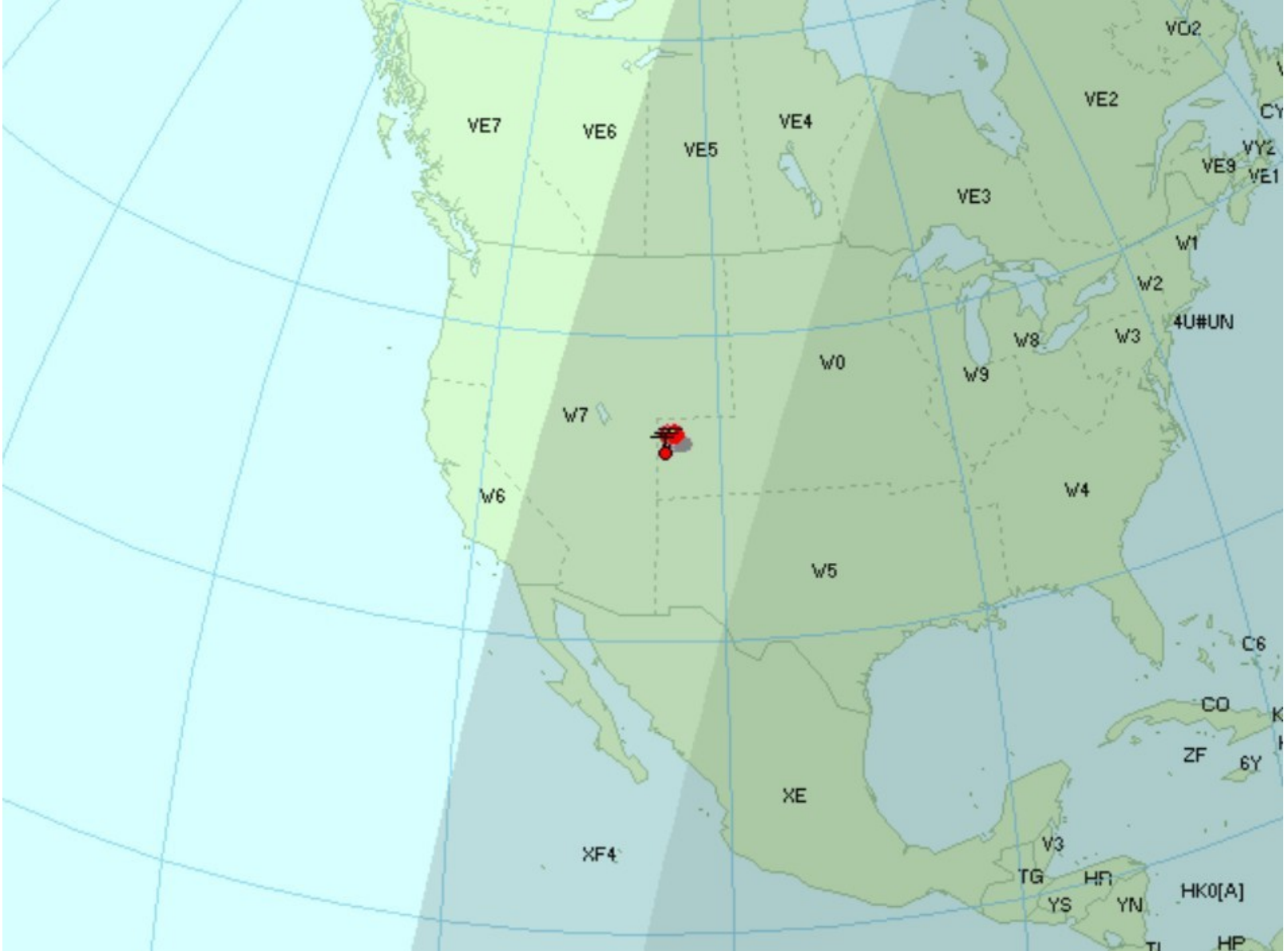
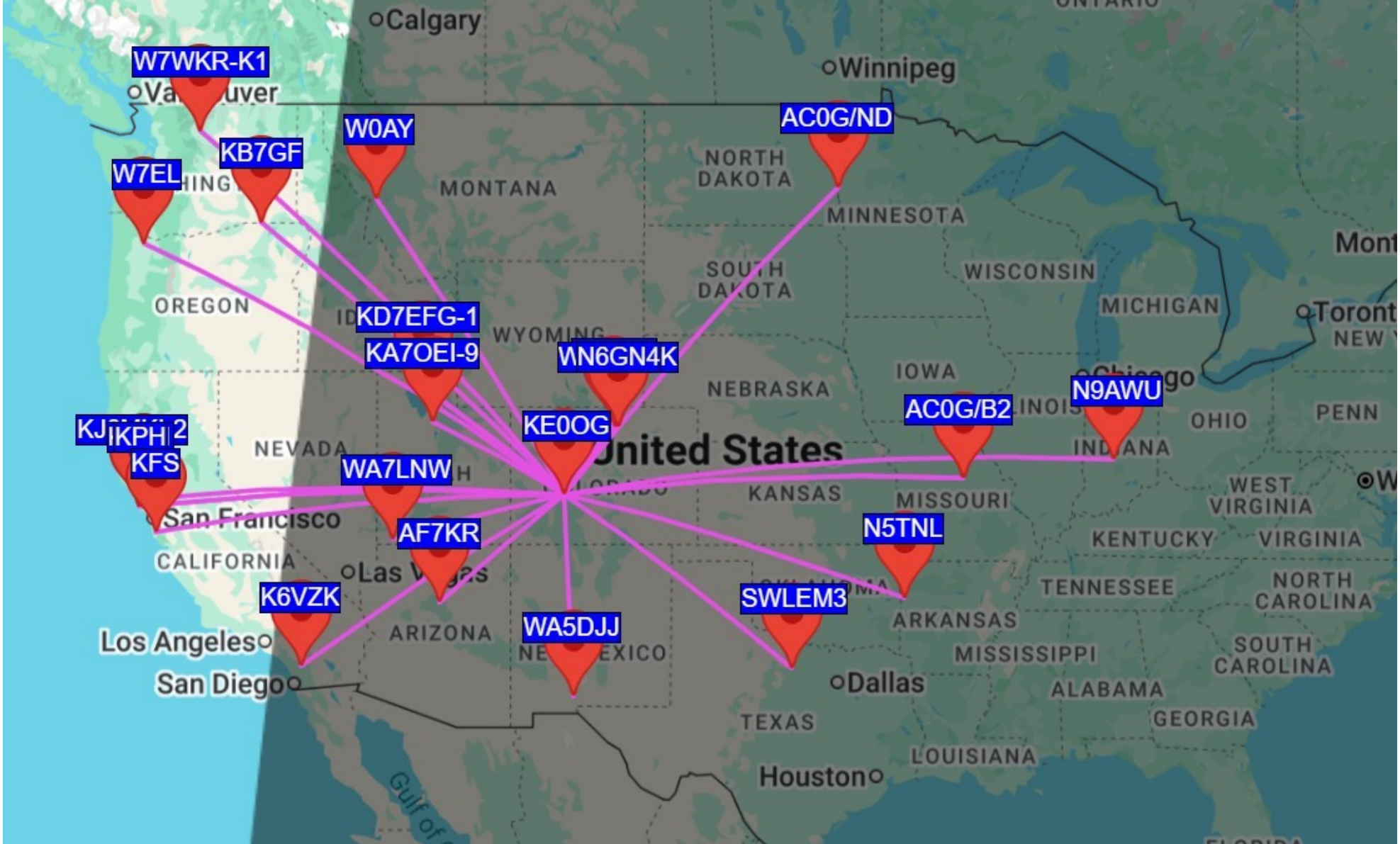
HP
HK
FO[C]
HC
TI9
HC8


VO2
VE2
VE7
VE6
VE5
VE4
VE3
VE9
VE1
W1
W2
4U#UN
W8
W3
W0
W9
W7
W6
W4
W5
C6
CO
ZF
6Y
XE
XF4
V3
TG
YS
YN
HK0[A]
HP


W7WKR-K1
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W7EL
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KD7EFG-1
KA7OEI-9
WN6GN4K
KE0OG
N9AWU
AC0G/B2
KJ[illegible]2
KPH
KFS
WA7LNW
AF7KR
N5TNL
K6VZK
WA5DJJ
SWLEM3
Calgary
Winnipeg
Vancouver
MONTANA
NORTH DAKOTA
MINNESOTA
SOUTH DAKOTA
WISCONSIN
MICHIGAN
OREGON
WYOMING
NEBRASKA
IOWA
NEVADA
KANSAS
MISSOURI
OHIO
INDIANA
KENTUCKY
WEST VIRGINIA
VIRGINIA
TENNESSEE
NORTH CAROLINA
SOUTH CAROLINA
ARKANSAS
MISSISSIPPI
ALABAMA
GEORGIA
LOUISIANA
TEXAS
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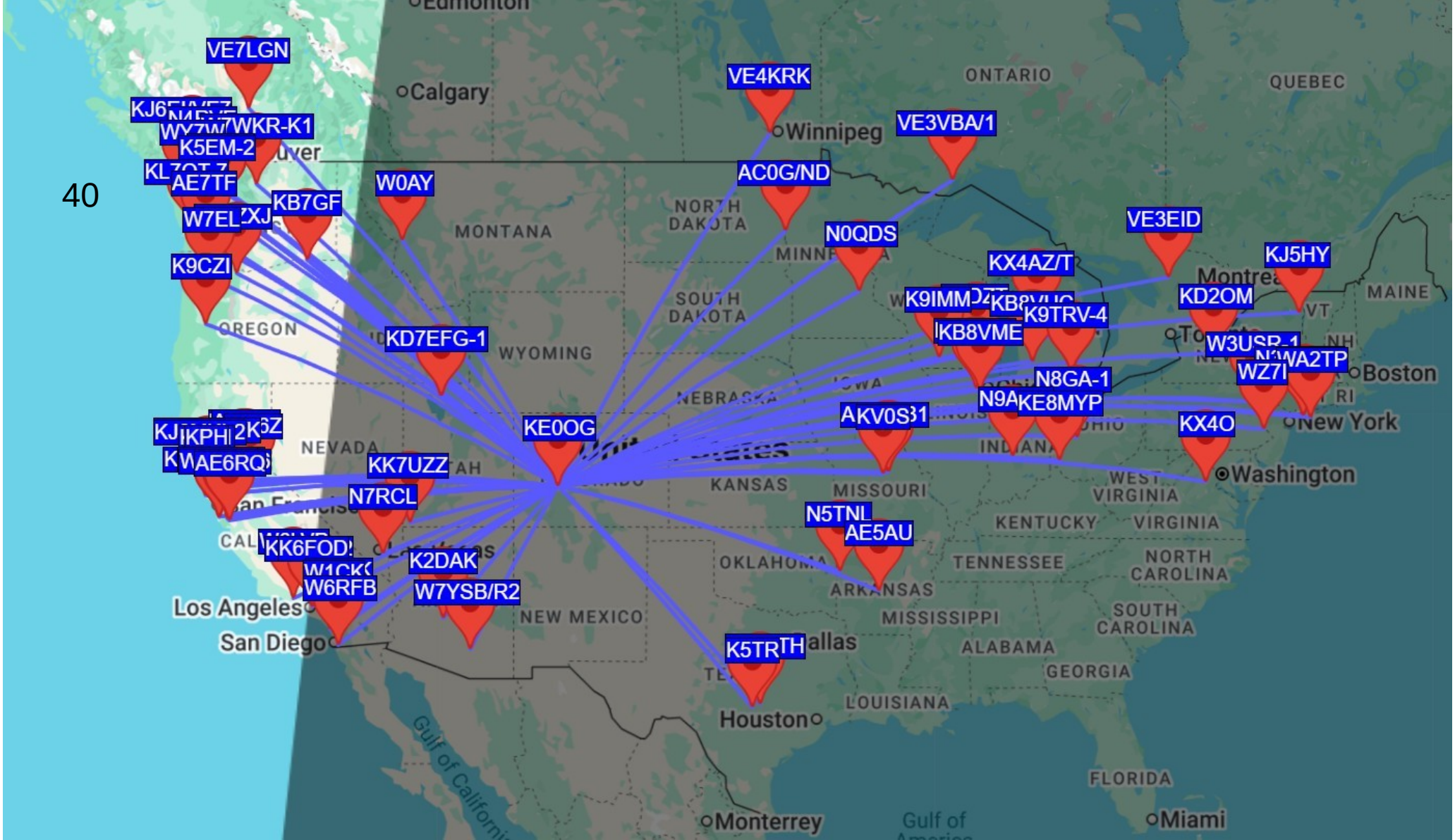
San Francisco
Los Angeles
San Diego
Las Vegas
Dallas
Houston
Toronto
United States


40
VE7LGN
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Winnipeg
ONTARIO
QUEBEC
VE3VBA/1
AC0G/ND
W0AY
KB7GF
K5EM-2
AE7TF
K9CZI
MONTANA
NORTH DAKOTA
SOUTH DAKOTA
N0QDS
VE3EID
KJ5HY
KX4AZ/T
K9TRV-4
KB8VME
KD2OM
MAINE
OREGON
KD7EFG-1
WYOMING
W3USR-1
WA2TP
WZ7I
Boston
New York
N8GA-1
N9AKE8MYP
AKV0S31
KX4O
KE0OG
NEVADA
KK7UZZ
N7RCL
KANSAS
MISSOURI
WEST VIRGINIA
Washington
N5TNL
AE5AU
KENTUCKY
VIRGINIA
KK6FOD
K2DAK
W6RFB
W7YSB/R2
OKLAHOMA
TENNESSEE
NORTH CAROLINA
Los Angeles
San Diego
NEW MEXICO
ARKANSAS
MISSISSIPPI
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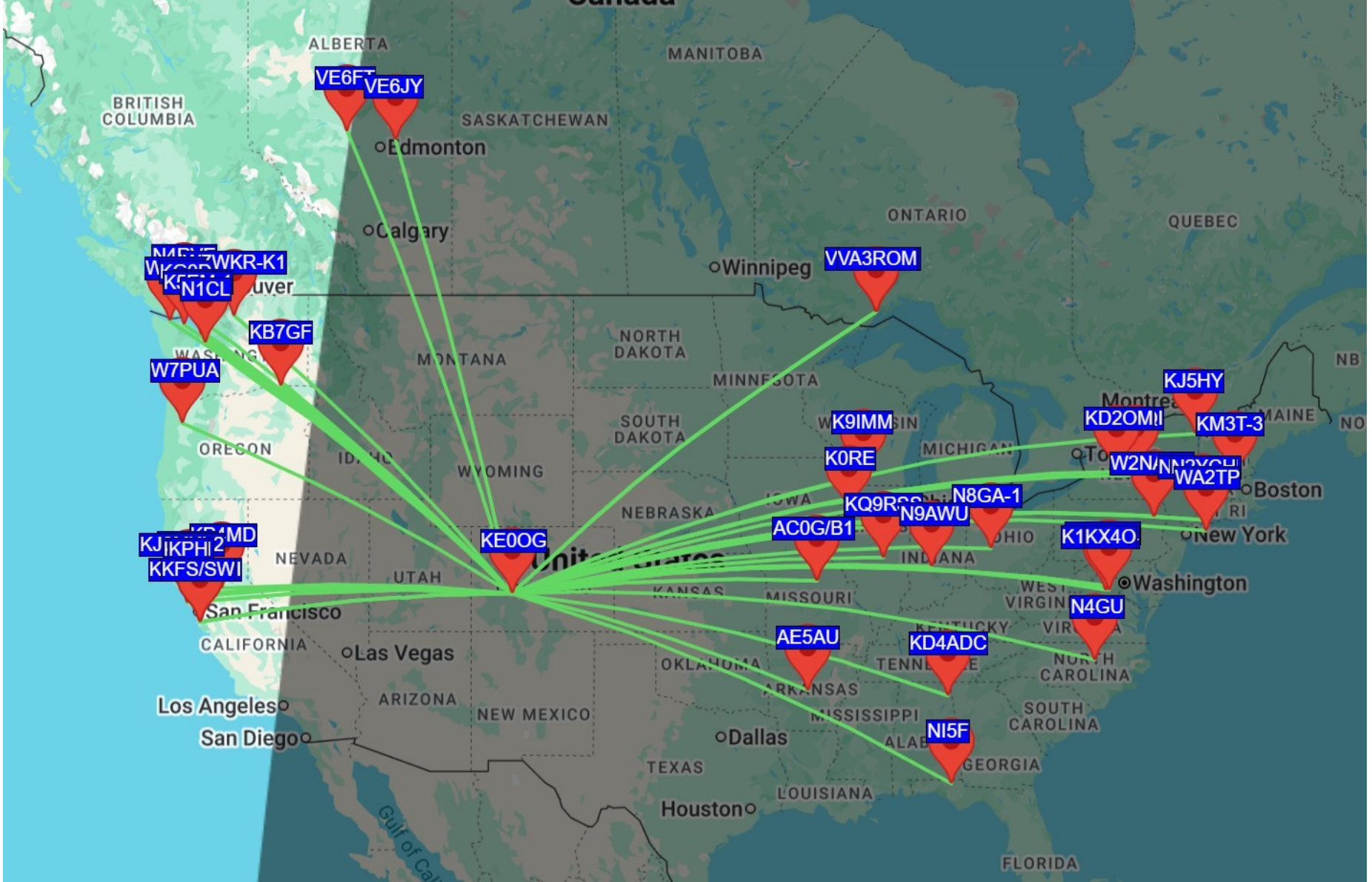
ALABAMA
GEORGIA
K5TR
Houston
LOUISIANA
FLORIDA
Monterrey
Miami
Gulf of


ALBERTA
MANITOBA
BRITISH COLUMBIA
SASKATCHEWAN
ONTARIO
QUEBEC
VE6JY
Edmonton
Calgary
Winnipeg
VVA3ROM
N1CL
KB7GF
W7PUA
NORTH DAKOTA
MONTANA
MINNESOTA
SOUTH DAKOTA
OREGON
WYOMING
NEBRASKA
NEVADA
UTAH
COLORADO
KANSAS
MISSOURI
CALIFORNIA
San Francisco
Las Vegas
ARIZONA
NEW MEXICO
Los Angeles
San Diego
Dallas
TEXAS
Houston
LOUISIANA
ARKANSAS
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
KENTUCKY
MICHIGAN
INDIANA
OHIO
WEST VIRGINIA
MAINE
Boston
New York
Washington
Montreal
KJ5HY
KD2OMII
KM3T-3
WA2TP
K9IMM
K0RE
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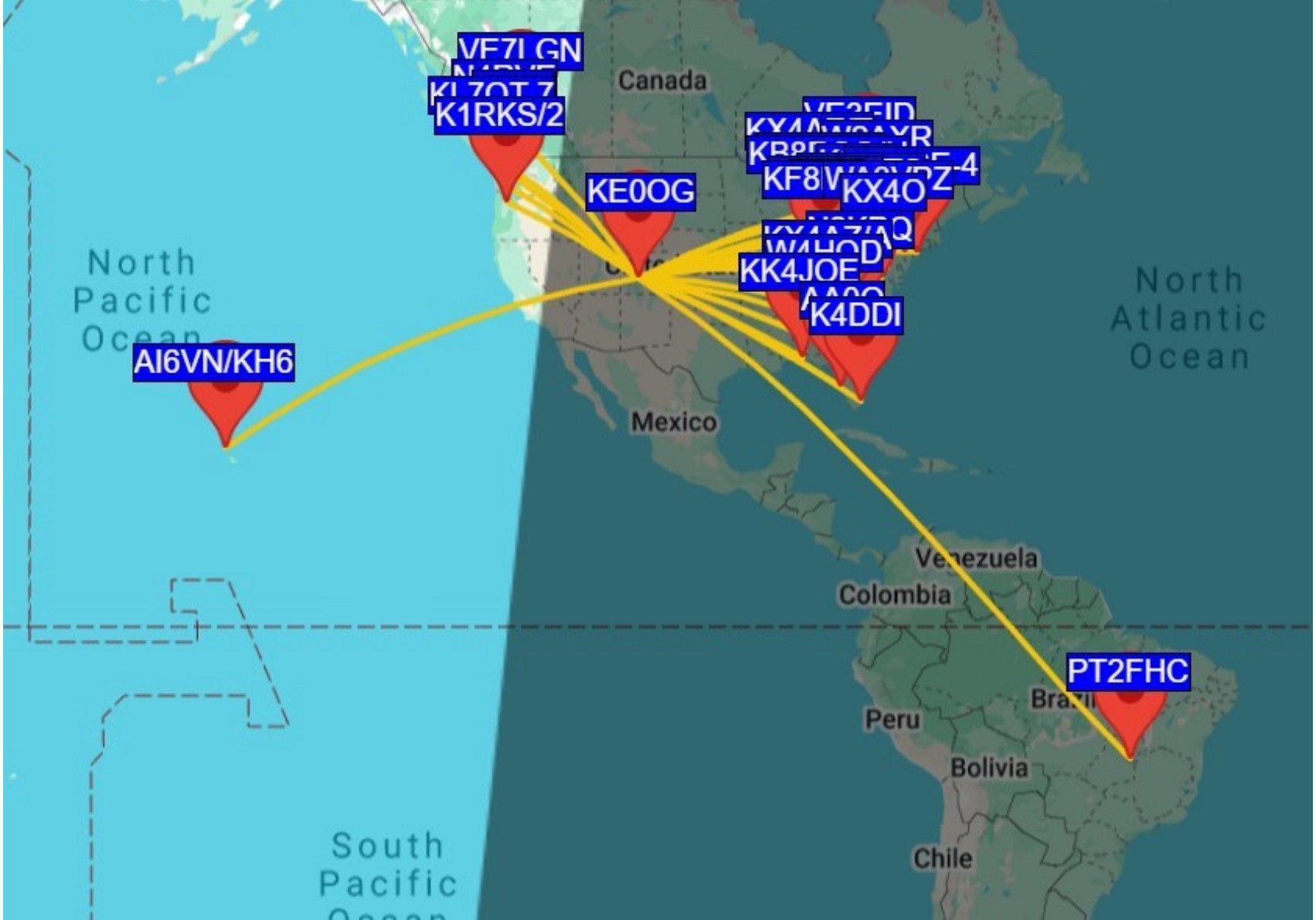
N4GU
AE5AU
KD4ADC
NI5F


K1RKS/2
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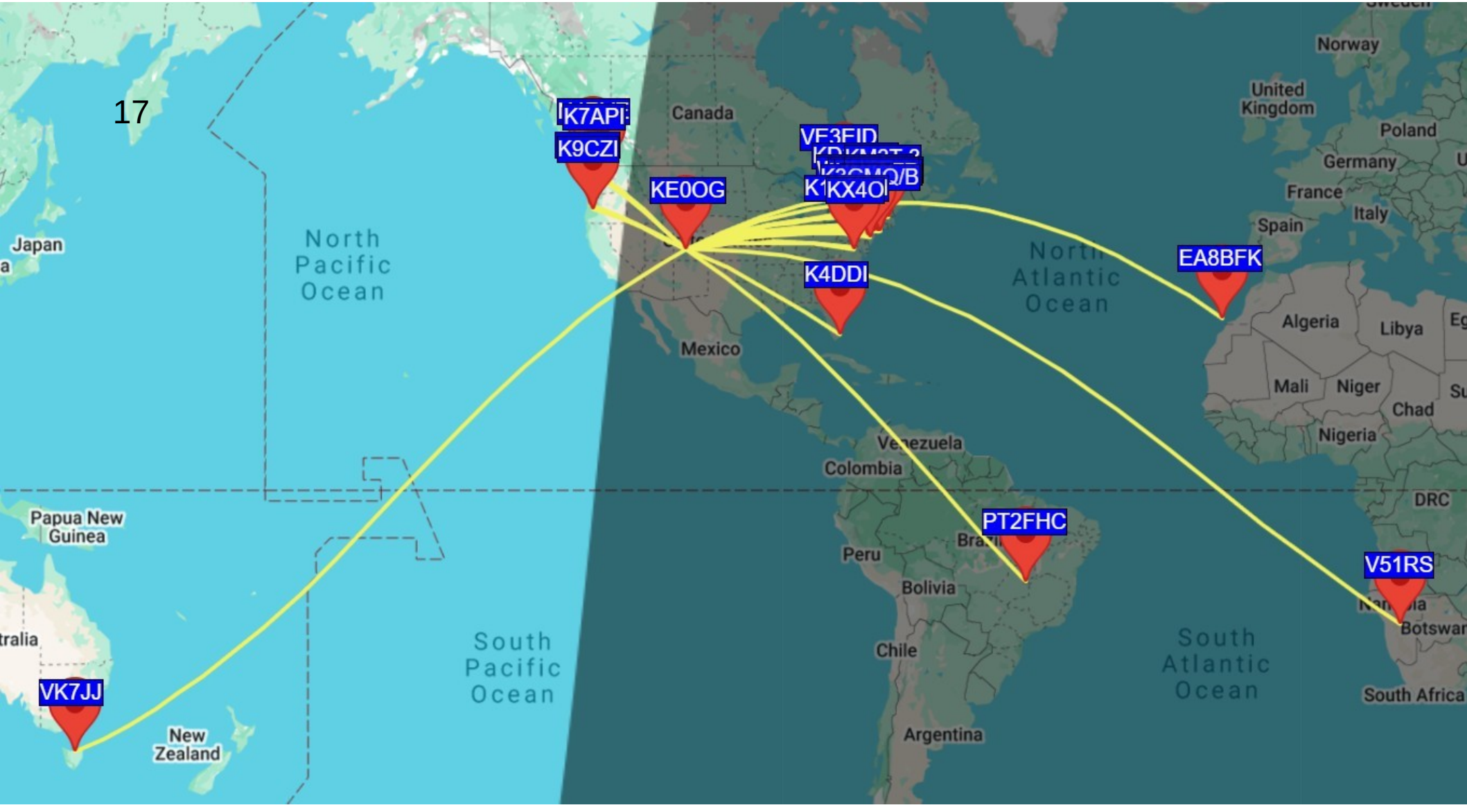
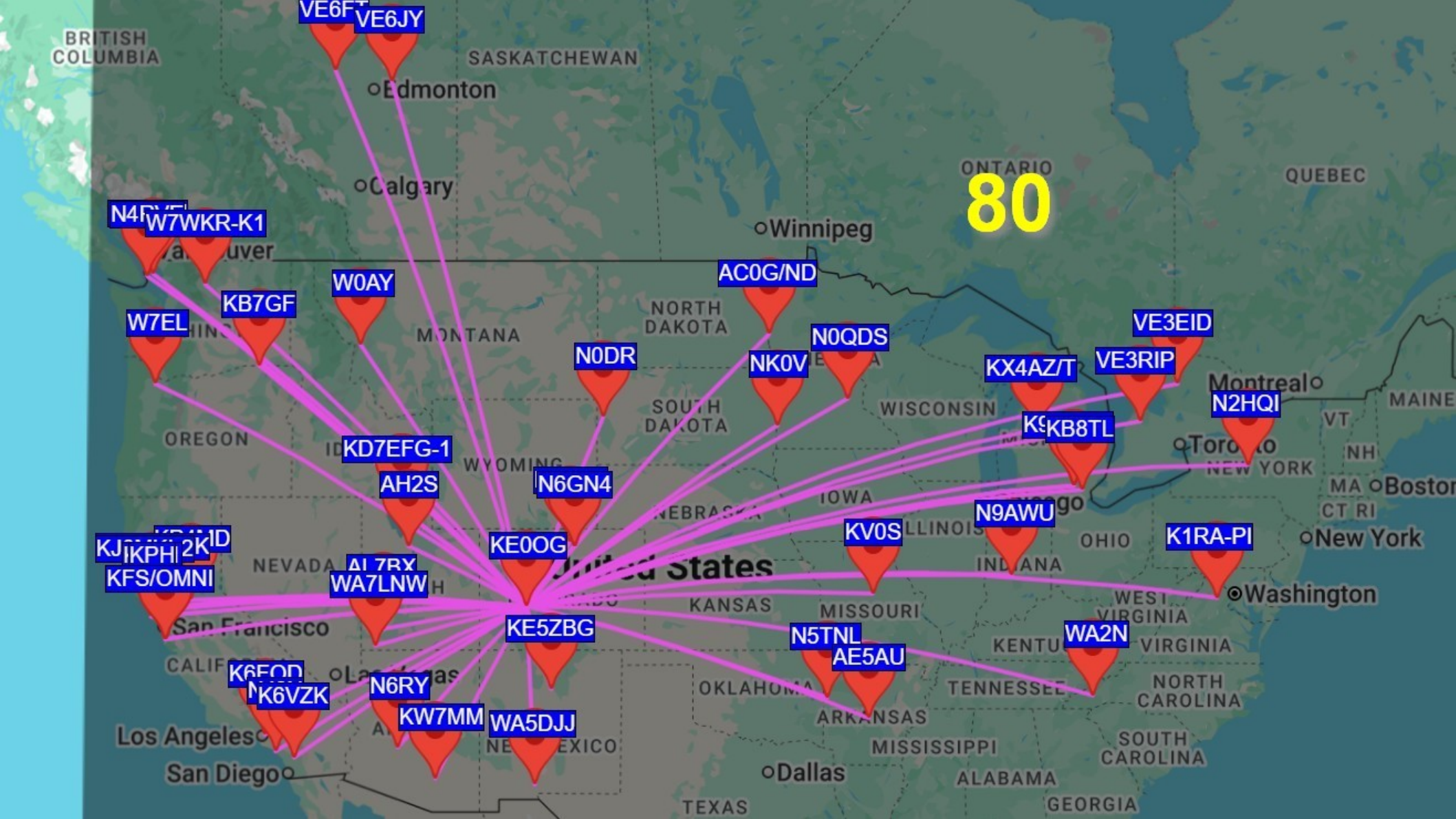
KX4O
KK4JOE
K4DDI
AI6VN/KH6
PT2FHC
Canada
Mexico
Venezuela
Colombia
Peru
Bolivia
Chile
North Pacific Ocean
South Pacific Ocean
North Atlantic Ocean


17
K7API
K9CZI
KE0OG
K1KX4OI
K4DDI
EA8BFK
PT2FHC
V51RS
VK7JJ
Canada
Mexico
Venezuela
Colombia
Peru
Bolivia
Chile
Argentina
Norway
United Kingdom
Poland
Germany
France
Spain
Italy
Algeria
Libya
Mali
Niger
Chad
Nigeria
DRC
South Africa
Japan
Papua New Guinea
New Zealand
North Pacific Ocean
South Pacific Ocean
North Atlantic Ocean
South Atlantic Ocean

15

Night

- 7:30 to 8:30 pm, 15 Sept 2025 MDT
- Nothing on 15, 12, 10


80
VE6F
VE6JY
BRITISH COLUMBIA
SASKATCHEWAN
Edmonton
Calgary
ONTARIO
QUEBEC
Winnipeg
W7WKR-K1
AC0G/ND
W0AY
KB7GF
W7EL
NORTH DAKOTA
MONTANA
N0QDS
N0DR
NK0V
VE3EID
KX4AZ/T
VE3RIP
Montreal
N2HQI
WISCONSIN
KB8TL
OREGON
KD7EFG-1
WYOMING
SOUTH DAKOTA
AH2S
N6GN4
IOWA
N9AWU
KV0S
K1RA-PI
New York
KE0OG
NEVADA
KFS/OMNI
WA7LNW
KANSAS
MISSOURI
OHIO
INDIANA
Washington
San Francisco
KE5ZBG
N5TNL
AE5AU
WA2N
WEST VIRGINIA
VIRGINIA
K6VZK
N6RY
KW7MM
WA5DJJ
OKLAHOMA
TENNESSEE
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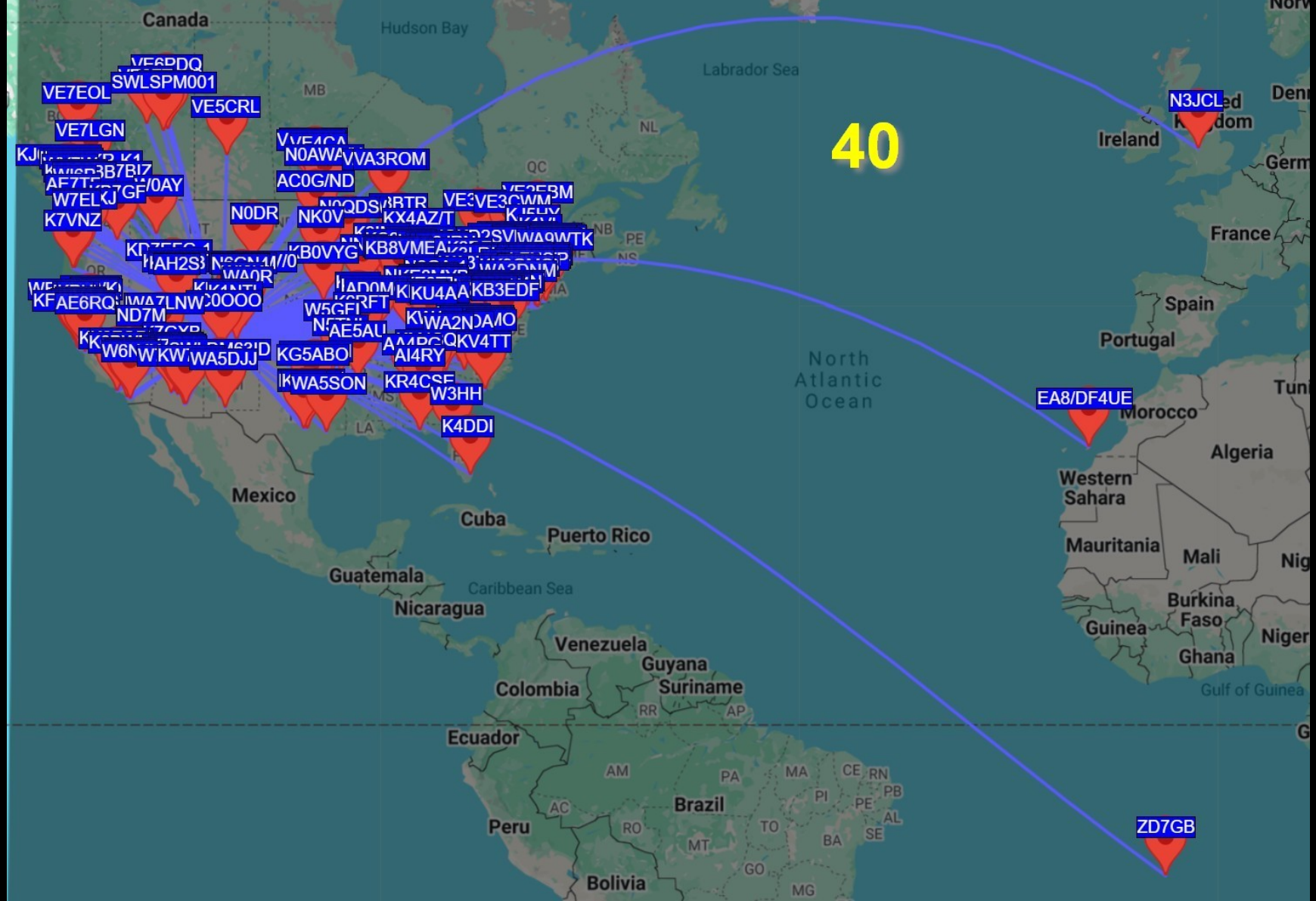
San Diego
MISSISSIPPI
SOUTH CAROLINA
Dallas
ALABAMA
TEXAS
GEORGIA


40
Canada
Hudson Bay
Labrador Sea
Ireland
France
Spain
Portugal
North Atlantic Ocean
Morocco
Algeria
Western Sahara
Mauritania
Mali
Burkina Faso
Guinea
Ghana
Gulf of Guinea
Mexico
Cuba
Puerto Rico
Guatemala
Caribbean Sea
Nicaragua
Venezuela
Guyana
Suriname
Colombia
Ecuador
Peru
Brazil
Bolivia
VE7EOL
SWLSPM001
VE5CRL
VE7LGN
N0AWA
VA3ROM
AC0G/ND
W7ELJ
K7VNZ
N0DR
NK0V
KX4AZ/T
KB0VYG
KB8VMEA
KU4AA
KB3EDF
W5GFI
AE5AU
WA2N
KV4TT
AI4RY
KG5ABO
WA5DJJ
WA5SON
KR4CSE
W3HH
K4DDI
ND7M
AE6RQ
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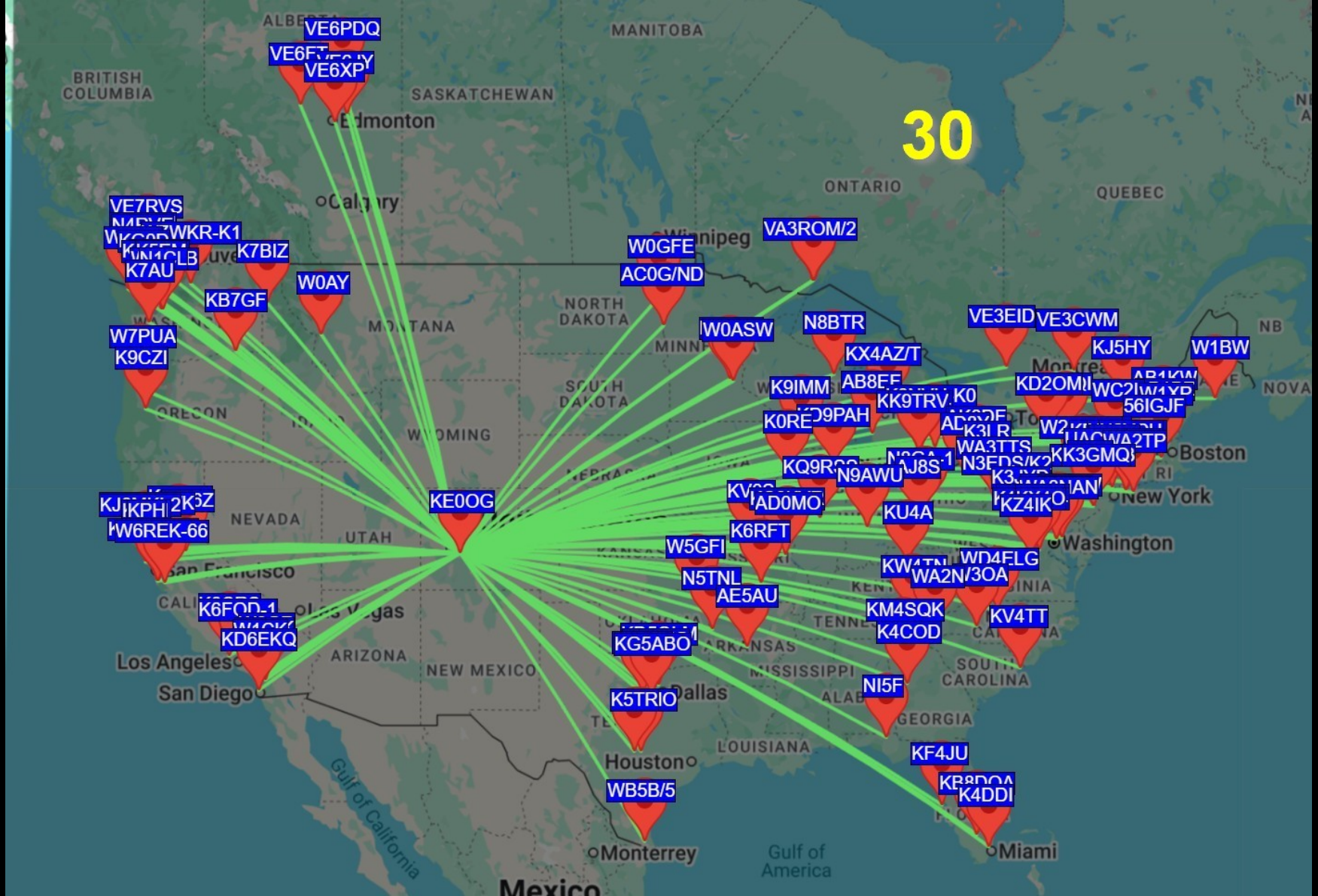
N3JCL
EA8/DF4UE
ZD7GB


30
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VE6XP
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K7AU
KB7GF
W0AY
W7PUA
K9CZI
W0GFE
AC0G/ND
VA3ROM/2
W0ASW
N8BTR
VE3EID
VE3CWM
KJ5HY
W1BW
KX4AZ/T
K9IMM
KK9TRV
K0RE
KD2OMI
56IGJF
KK3GMQ
N9AWU
KU4A
K6RFT
W5GFI
N5TNL
AE5AU
KE0OG
W6REK-66
KG5ABO
K5TRIO
WB5B/5
KM4SQK
K4COD
KV4TT
NI5F
KF4JU
K4DDI
KD6EKQ
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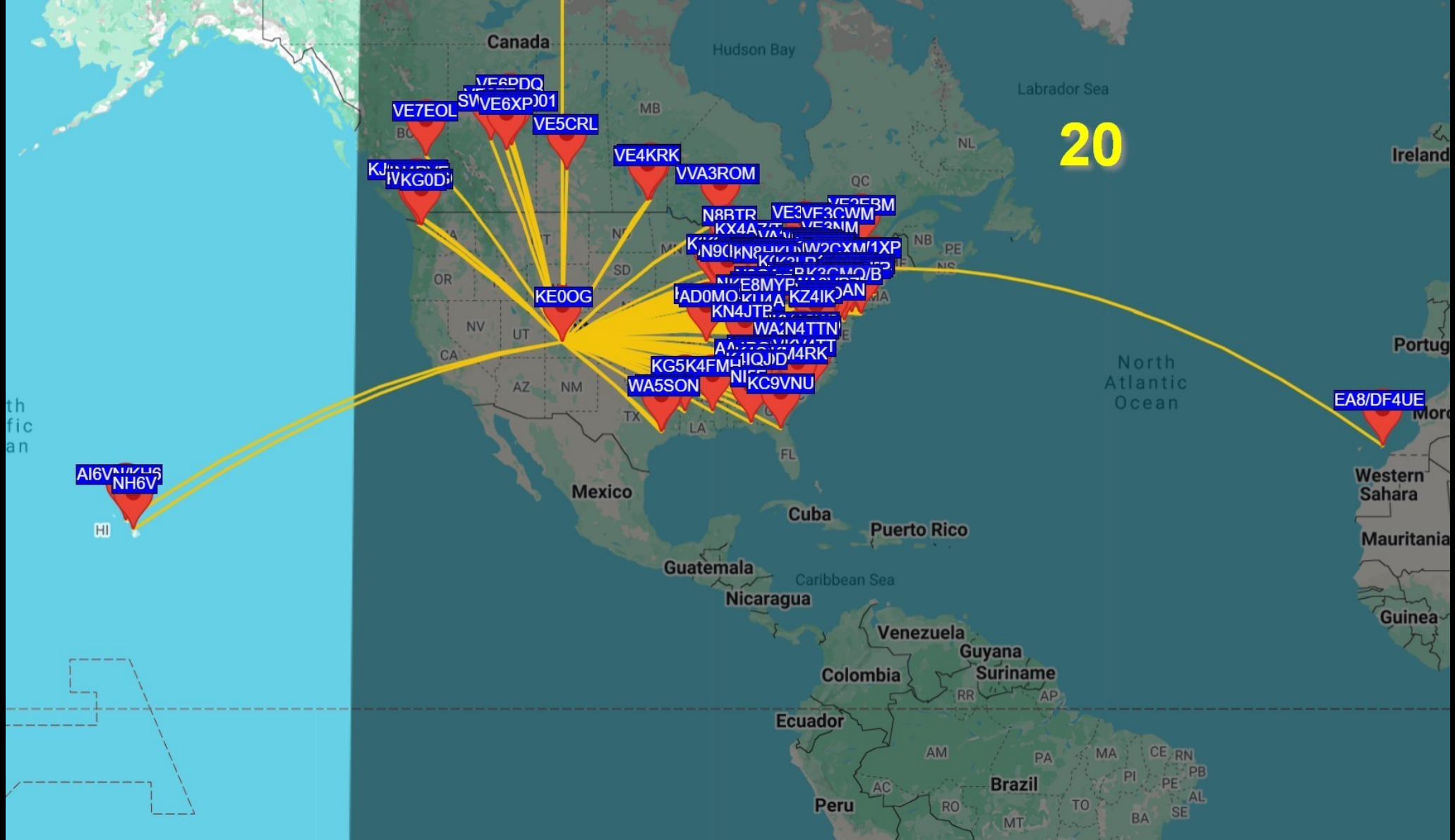
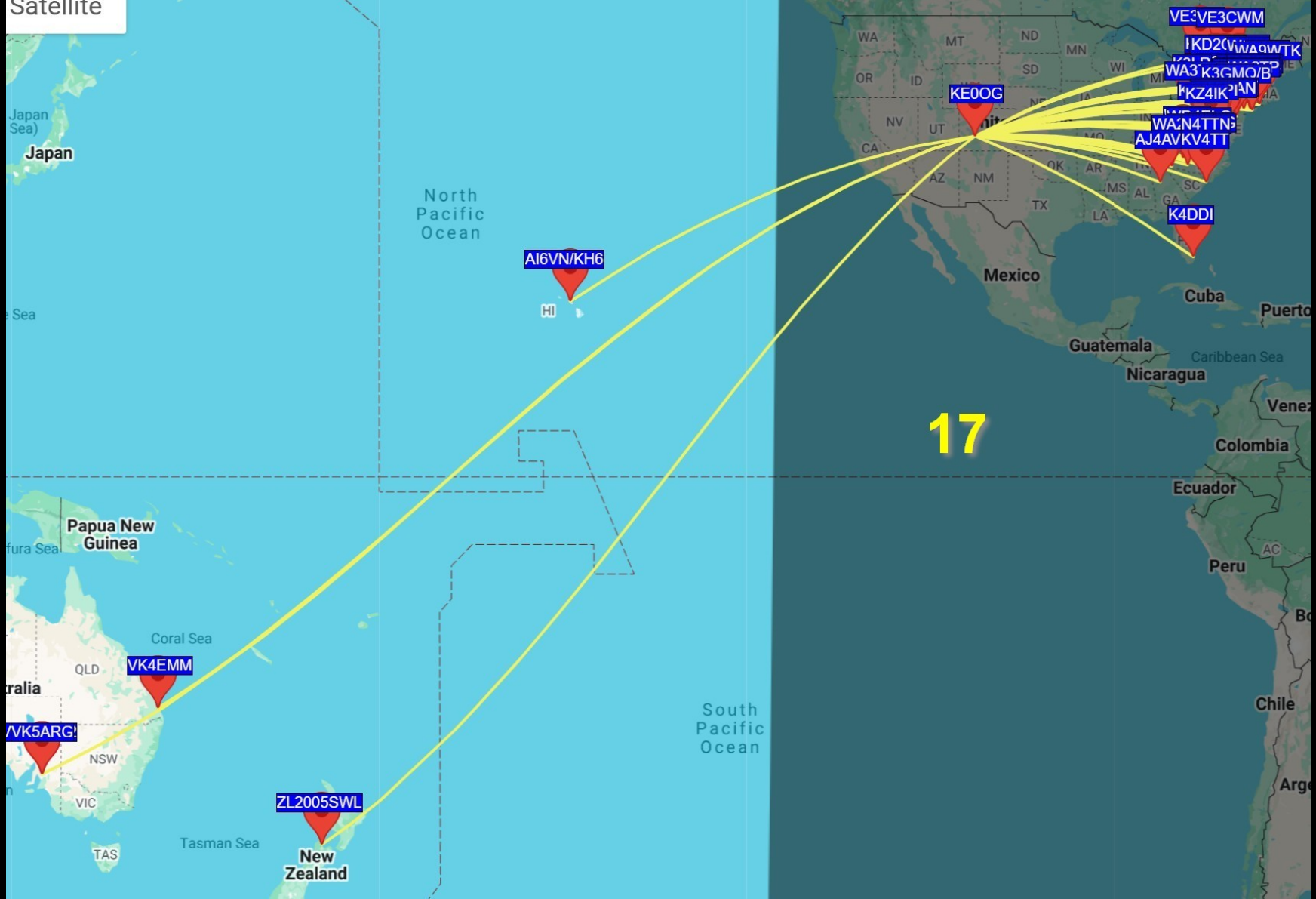
Miami
Mexico
Gulf of America
Gulf of California


20
VE7EOL
VE6XP
VE5CRL
VE4KRK
VVA3ROM
KE0OG
WA5SON
KG5K4FM
KC9VNU
KZ4IK
KN4JTR
NH6V
EA8/DF4UE
Canada
Hudson Bay
Labrador Sea
Mexico
Cuba
Puerto Rico
Guatemala
Nicaragua
Caribbean Sea
Venezuela
Guyana
Suriname
Colombia
Ecuador
Peru
Brazil
North Atlantic Ocean
Western Sahara
Mauritania
Guinea
Ireland
HI


Satellite
VE3CWM
KE0OG
AJ4AVKV4TT
K4DDI
AI6VN/KH6
HI
VK4EMM
VK5ARG
ZL2005SWL
17
North Pacific Ocean
South Pacific Ocean
Japan
Mexico
Cuba
Guatemala
Nicaragua
Caribbean Sea
Colombia
Ecuador
Peru
Chile
Papua New Guinea
Coral Sea
Tasman Sea
New Zealand
QLD
NSW
VIC
TAS

Summary

- WSPR is amazing, even at 200 mW (23 dBm)
- Error-control coding is amazing
- Nice if you can switch quickly between bands
  - Requires an “all band” antenna like an 80-10m EFHW
- “Gray line” was a bust, but day vs night sure showed differences