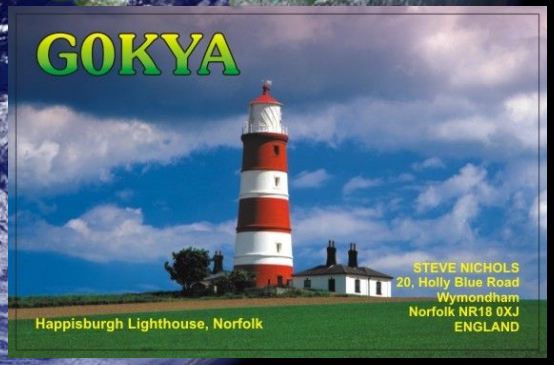
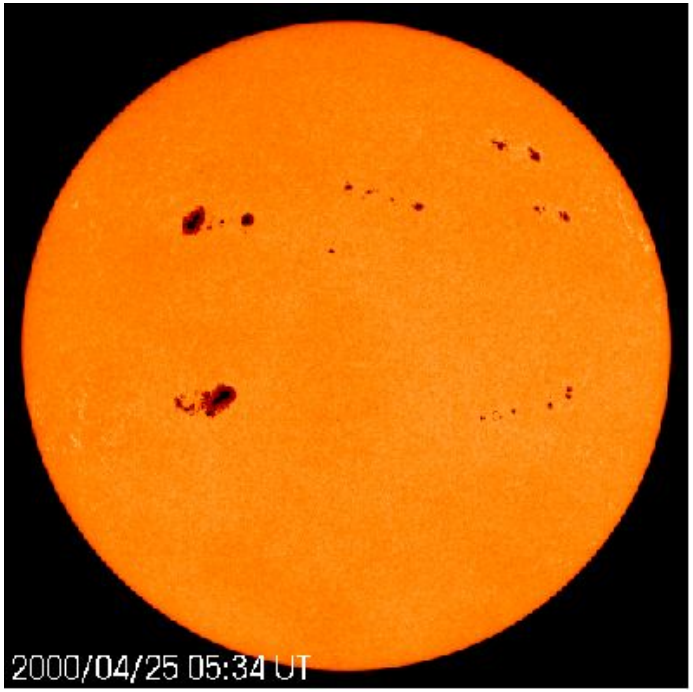
HF Propagation Prediction Programs – and how to use them

Steve Nichols
G0KYA



Quick recap

- HF paths depend upon:
  - Time of day
  - Time of year
  - Band in use
  - Solar Flux – EM radiation
  - Geomagnetic Conditions – Solar particulate output
  - The path itself
    - over land?
    - over sea?
    - how many hops?
    - daylight/night path?
    - TX/RX antenna gain?
    - a good dose of luck?



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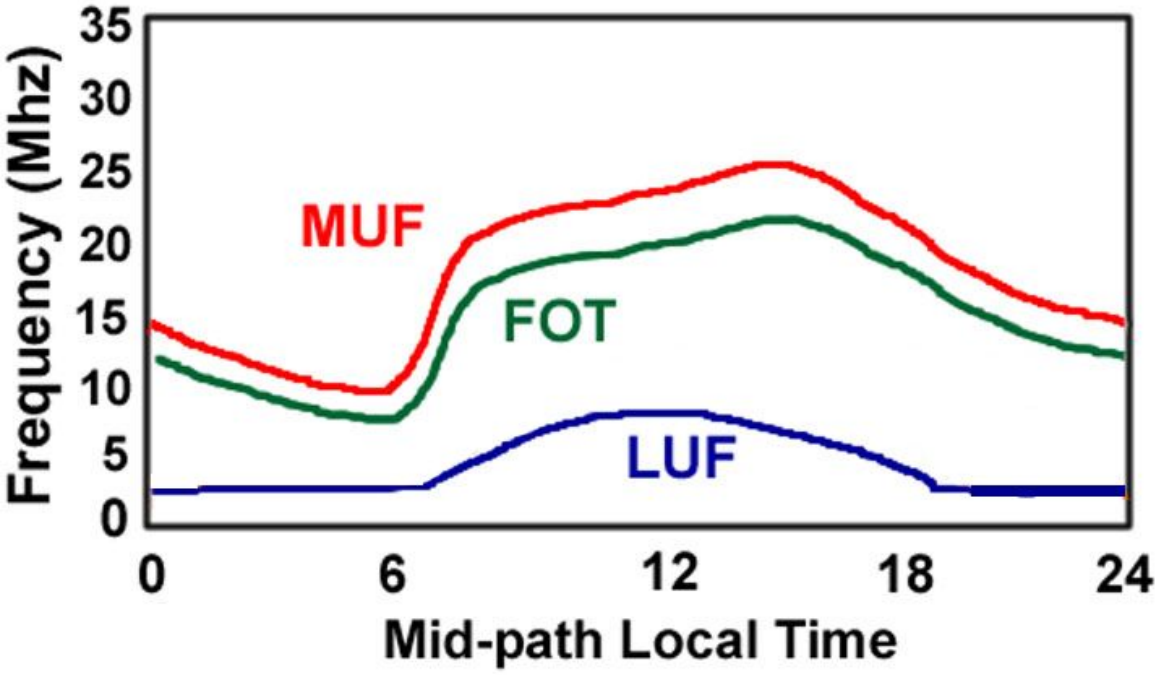
Quick recap



The FOT (Frequency of Optimum Transmission) gives the highest “probability” for the contact you want to make.

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Basic history of prediction programs and models

- Late 60s – Standard model of the ionosphere developed
- Late 70s - IONCAP developed by George Lane from VOA then by Teters et al. for NTIA/ITS
- 1982 - MINIMUF developed for NOAA – did not include the earth's magnetic field and left out equatorial anomaly
- Mid '80s – Raymond Fricker of BBC External Services releases MICROMUF and MAXIMUF, which included the role of the geomagnetic field and put in radiation angles
- 1993 VOACAP released, developed by George Lane improving the IONCAP model, corrected some algorithms, added new functions
- 2001 W6ELProp released

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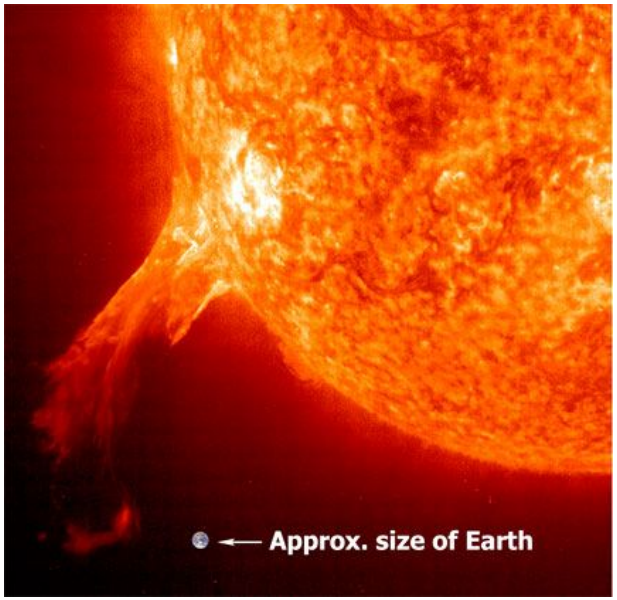
What Prediction Programs are out there?

- There are now really two basic types - based on:

The Raymond Fricker model
- W6ELProp

The VOACAP model
- VOACAP
- VOAProp
- HamCAP
- WinCap Wizard
- ACE HF
- and others



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20 Meters: Oct., England (London), for SSN = Very Low, Sigs in S-Units. By N6BV, ARRL.

Zone	UTC --> 00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
KL7 = 01	-	-	-	-	-	-	-	-	-	1	2	2	2	3	3	4	6	8	8	6	5	2	1	1
VO2 = 02	2	2	2	4	-	-	-	-	-	-	7	9+	9+	9+	9+	9+	9+	9+	9+	9+	8	1	4	2
W6 = 03	2	2	2	-	-	-	-	-	-	-	-	-	-	-	5	8	9	9	9	8	8	5	1	2
W9 = 04	-	-	-	-	-	-	-	-	-	-	-	2	8	9	9	9	9	9	9	9	8	6	1	-
W3 = 05	-	-	-	-	-	-	-	-	-	-	-	9	9	9	9+	9	9	9+	9+	9	9	8	1	-
XE1 = 06	2	1	2	-	-	-	-	-	-	-	-	-	8	9	8	8	8	8	8	8	8	8	6	1
TI = 07	1	2	-	1	-	-	-	-	3	-	1	9	9	8	8	8	7	8	8	8	9	8	8	3
VP2 = 08	-	-	1	-	-	-	-	-	-	4	9+	9+	9	8	8	8	9	9	9+	9+	9+	8	5	1
P4 = 09	1	1	3	2	-	-	-	-	-	3	9	9+	9	8	8	8	9	9	9+	9+	9	8	6	4
HC = 10	3	3	6	3	-	-	-	-	4	2	7	9	8	7	6	6	6	7	8	8	9	9	7	3
PY1 = 11	3	4	8	9	6	-	1	8	9	9+	9	7	5	5	4	4	6	9	9+	9+	9+	9	8	6
CE = 12	2	4	8	8	3	-	-	8	9	8	9	7	5	2	4	3	1	3	6	9	9	9	7	4
LU = 13	2	4	9	9	7	-	-	9+	9	9	8	6	4	4	2	1	2	5	7	9	9	9	8	6
G = 14	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	3	3	3
I = 15	-	-	-	-	-	-	-	6	9+	9+	9+	9+	9+	9+	9+	9+	9+	6	4	3	1	-	-	-
UA3 = 16	-	-	-	-	-	-	9+	-	2	4	9+	9+	8	6	5	2	-	9	9+	9+	8	4	2	-
UN = 17	-	-	-	-	-	6	9	9+	9+	9+	9+	9+	9+	9+	9+	9+	9	7	3	1	-	-	-	-
UA9 = 18	-	-	-	-	-	-	9	9	9	9	9+	9+	9	9	7	5	2	1	-	-	-	-	-	-
UA0 = 19	-	-	-	-	-	-	4	8	9	9	9	8	5	4	4	3	2	1	-	-	1	-	-	-
4X = 20	9	8	6	4	7	-	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	6	9	9	9	8	9
HZ = 21	-	-	-	-	-	9+	9+	9+	9	9	9	9	9+	9+	9+	9+	9+	9+	8	4	-	-	-	-
VU = 22	-	-	-	-	-	7	9	9	9	9	9	9+	9+	9+	9+	9+	8	7	5	4	1	-	-	-
JT = 23	-	-	-	-	-	-	5	8	9	9	9	9+	8	6	4	3	-	-	-	-	-	-	-	-
VS6 = 24	-	-	-	-	-	4	8	8	9	9	9	9	9+	9+	9+	9	8	9	8	7	5	2	1	-
JA1 = 25	-	-	-	-	-	-	6	9	9	9	9	9	9	8	8	9	8	8	8	7	3	1	-	-
HS = 26	-	-	-	-	-	7	7	7	8	9	8	9	9	9+	9+	8	7	6	3	7	6	3	-	-
DU = 27	-	-	-	-	-	3	7	8	8	8	9	9	9	9+	9	9	9	8	7	5	5	-	1	1
YB = 28	2	-	-	-	-	5	3	6	7	9	8	9	9	9	9+	9+	9+	9+	9+	8	7	6	-	5
VK6 = 29	2	-	-	-	-	-	-	1	1	9	5	7	8	9	9	9	9	9+	9	6	8	5	5	6
VK3 = 30	-	-	-	-	-	2	2	8	7	6	7	8	8	9	9	9	9+	9	8	4	1	2	-	-
KH6 = 31	1	1	-	-	-	-	2*	1*	4	5	6	5	5	4	2	2	8	9	9	8	4	2	1	1
KH8 = 32	-	-	-	-	-	-	3*	2*	5	6	9	9	9	9	9	5	1	9	9	7	2	1	-	-
CN = 33	-	-	2	1	-	-	3	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	8	3	-
SU = 34	9	9	8	5	7	-	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	9+	7	9	9+	9	9	9
6W = 35	-	-	-	1	-	-	-	9+	9+	9+	9+	9	9	9	9	9+	9+	9+	9+	9+	9+	4	-	-
D2 = 36	-	2	6	5	-	2	9+	9+	9	8	6	7	5	7	9	9+	9+	9+	9+	9+	8	6	1	-
5Z = 37	-	-	-	-	-	5	9+	9+	9	6	5	6	8	9	9+	9+	9+	9+	9+	9	8	5	-	-
ZS6 = 38	4	8	8	6	1	8	9	9	7	5	2	4	5	6	8	9	9+	9+	9+	9+	9	8	5	4
FR = 39	7	9	4	3	7	9	9	8	6	2	2	4	7	8	9+	9+	9+	9+	9+	9+	9	8	8	8
FJL = 40	1	-	-	-	-	-	4	9	-	2	5	7	8	8	7	5	1	9	9	8	7	4	2	2
Zone	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

UTC --> * = Longpath

Expected signal levels using 1500 W and 3-element Yagis at 100 feet at each station.

If you hate computers you could use the charts from the ARRL ...

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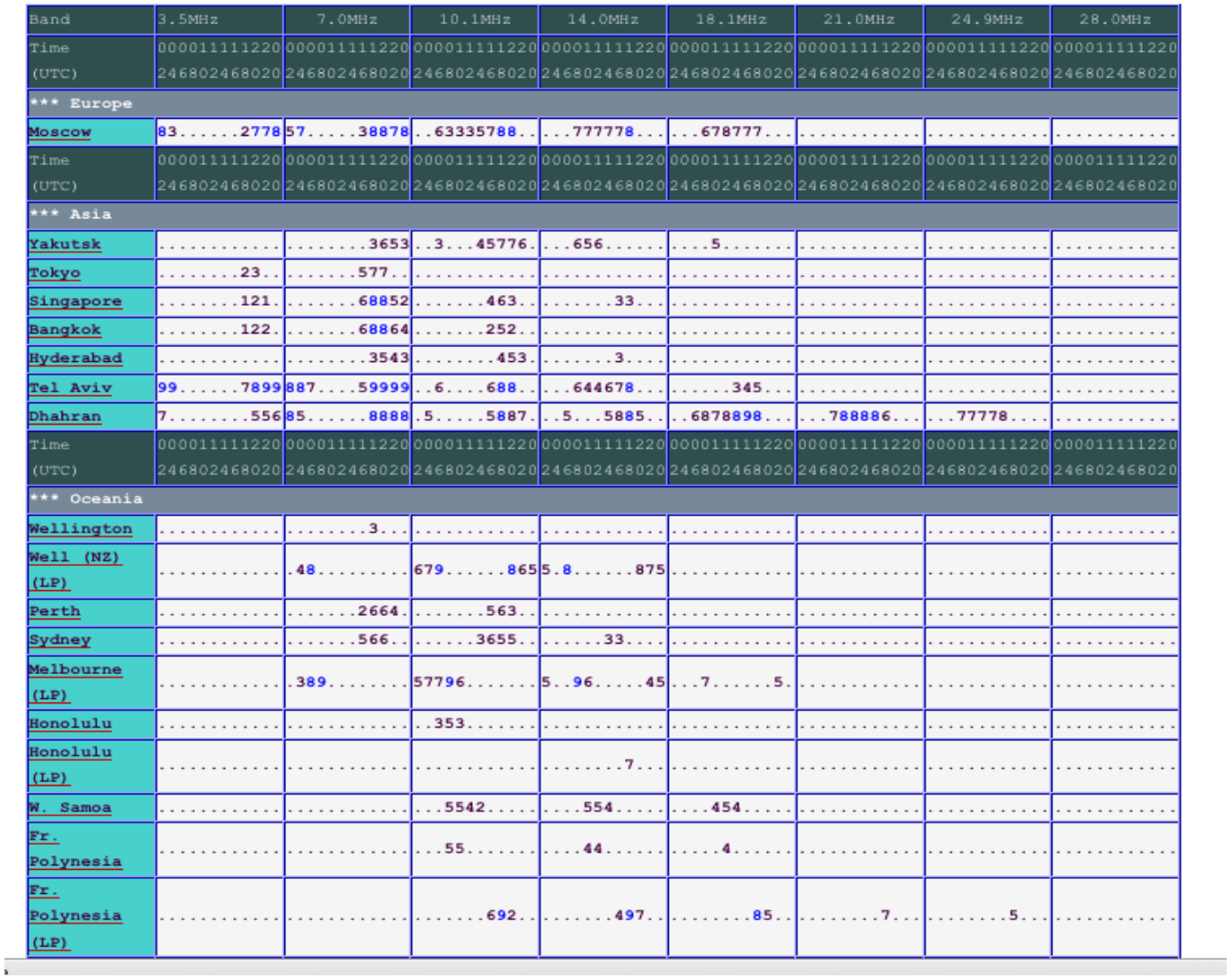

Band	3.5MHz	7.0MHz	10.1MHz	14.0MHz	18.1MHz	21.0MHz	24.9MHz	28.0MHz
Time (UTC)	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020
*** Europe								
Moscow	83.....2778	57.....38878	..63335788..	...777778...	...678777...			
Time (UTC)	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020
*** Asia								
Yakutsk		3653	..3...45776.	...656.....	....5.....			
Tokyo	.....23..	.....577..						
Singapore	.....121.	68852	.....463..	.....33...				
Bangkok	.....122.	68864	.....252..					
Hyderabad		3543	.....453.	.....3....				
Tel Aviv	99.....7899	887....59999	..6....688..	...644678...	.....345...			
Dhahran	7.....556	85.....8888	.5.....5887.	..5...5885..	..6878898...	...788886...	...77778...	
Time (UTC)	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020
*** Oceania								
Wellington		.....3...						
Well (NZ) (LP)		.48.....	679.....865	5.8.....875				
Perth		.....2664.	.....563..					
Sydney		.....566..	.....3655..	.....33....				
Melbourne (LP)		.389.....	57796.....	5..96.....45	...7.....5.			
Honolulu			..353.....					
Honolulu (LP)				.....7...				
W. Samoa			...5542.....	....554.....	....454.....			
Fr. Polynesia			...55.....	....44.....	.....4.....			
Fr. Polynesia (LP)			.....692..	.....497..	.....85..	.....7...	.....5...	

… or those from Gwyn Williams, G4FKH, on the RSGB's web site

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Propagation predictions for RSGB SSB HF Field Day, September 2008

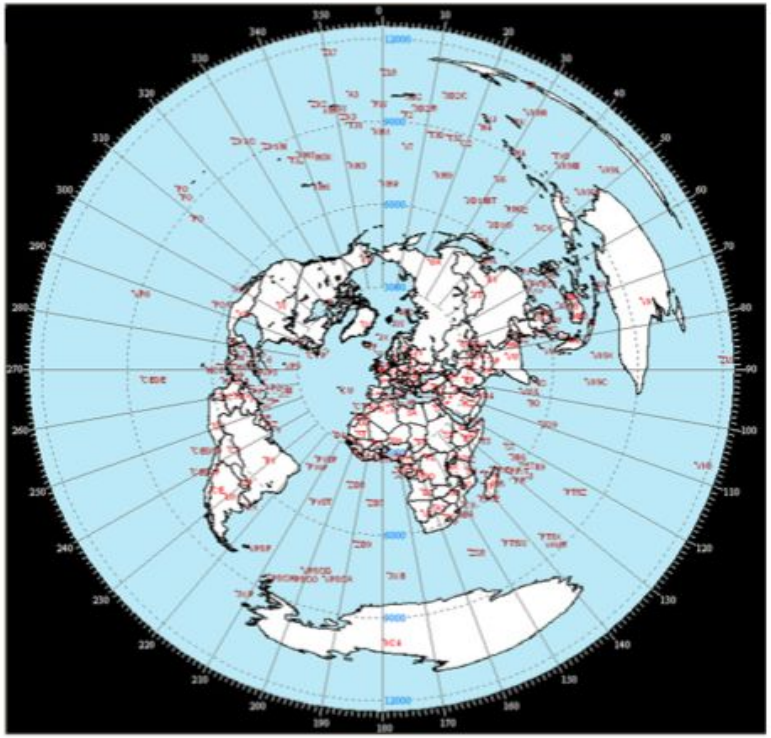
Below is a great circle map of the world. This shows the beam headings for short-path contacts. Add 180 degrees for long-path.

There then follows pages showing hourly propagation predictions for the three best bands, plus a short commentary for each. These have been prepared using VOAProp (VOACAP based) and a solar flux prediction of about 70 and a K index of 1 (settled conditions).

Although the charts suggest that 15m and 10m may not be very good bands at this point in the solar cycle do try them - they are both likely to open during the day, if only for short periods.

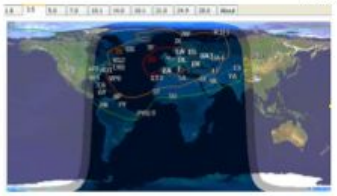
Notice the long-path 20m openings that may exist for well-equipped stations.

Steve Nichols, G0KYA
RSGB Propagation Studies Committee



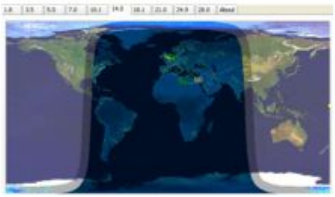
Great circle map from UK - generated with AZMAP

0000 UTC



80 metres

40 metres



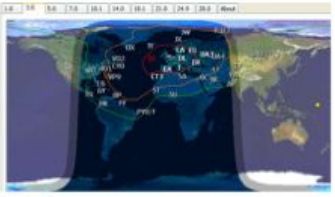
20 metres

15 and 10 metres are likely to be closed. 20m is also unlikely to be open, but do check.

Best bands are 80m and 40m

Look for good DX openings to South America and South Africa, especially on 40m

0100 UTC



80 metres

40 metres

20 metres

15 and 10 metres are likely to be closed. 20m is also unlikely to be open, but do check.

Best bands are still 80m and 40m

Look for good DX openings to North and South America and South Africa, especially on 40m

Or you can produce your own hour by hour, band by band “book” (this one using VOAProp)

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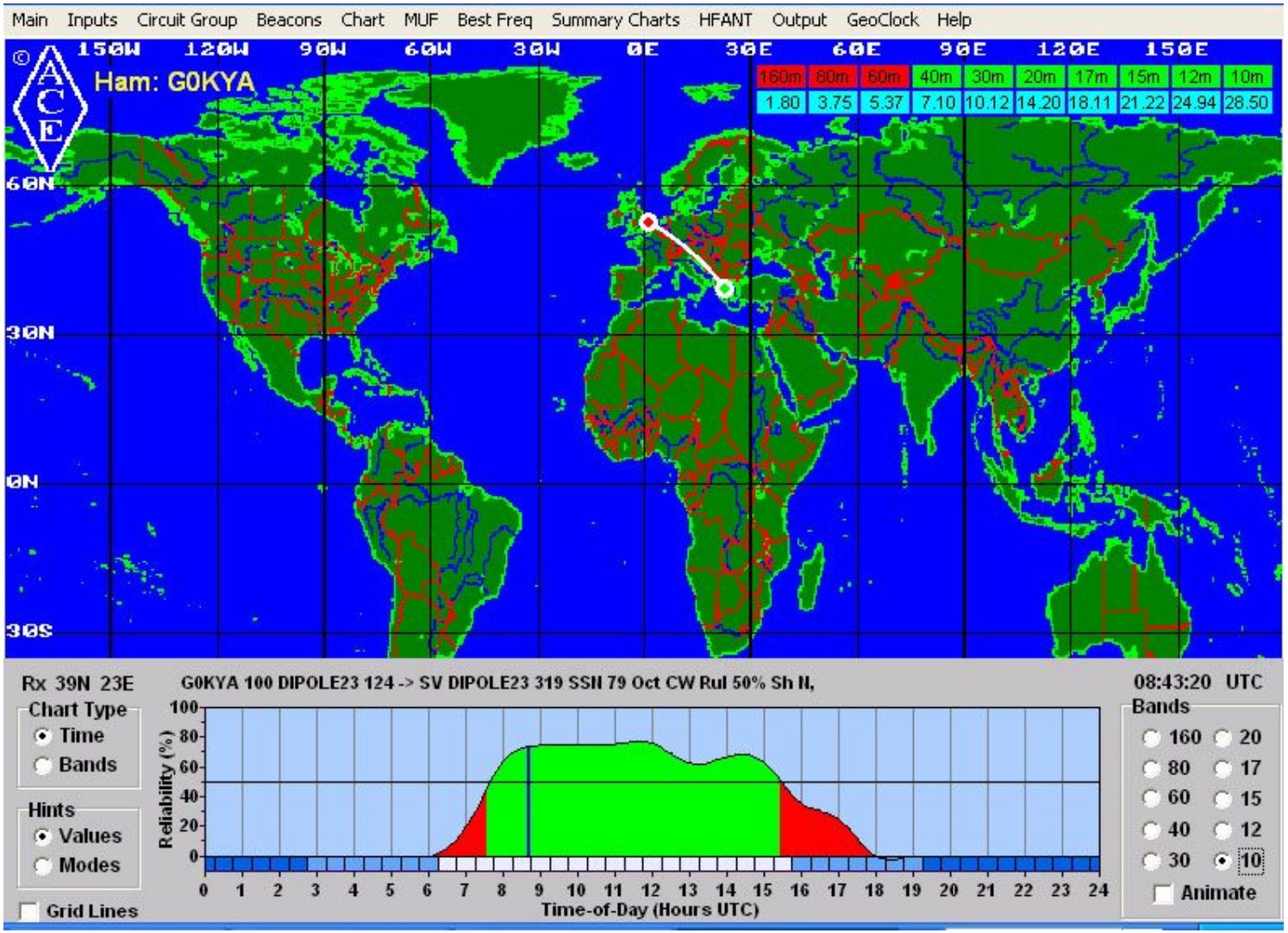
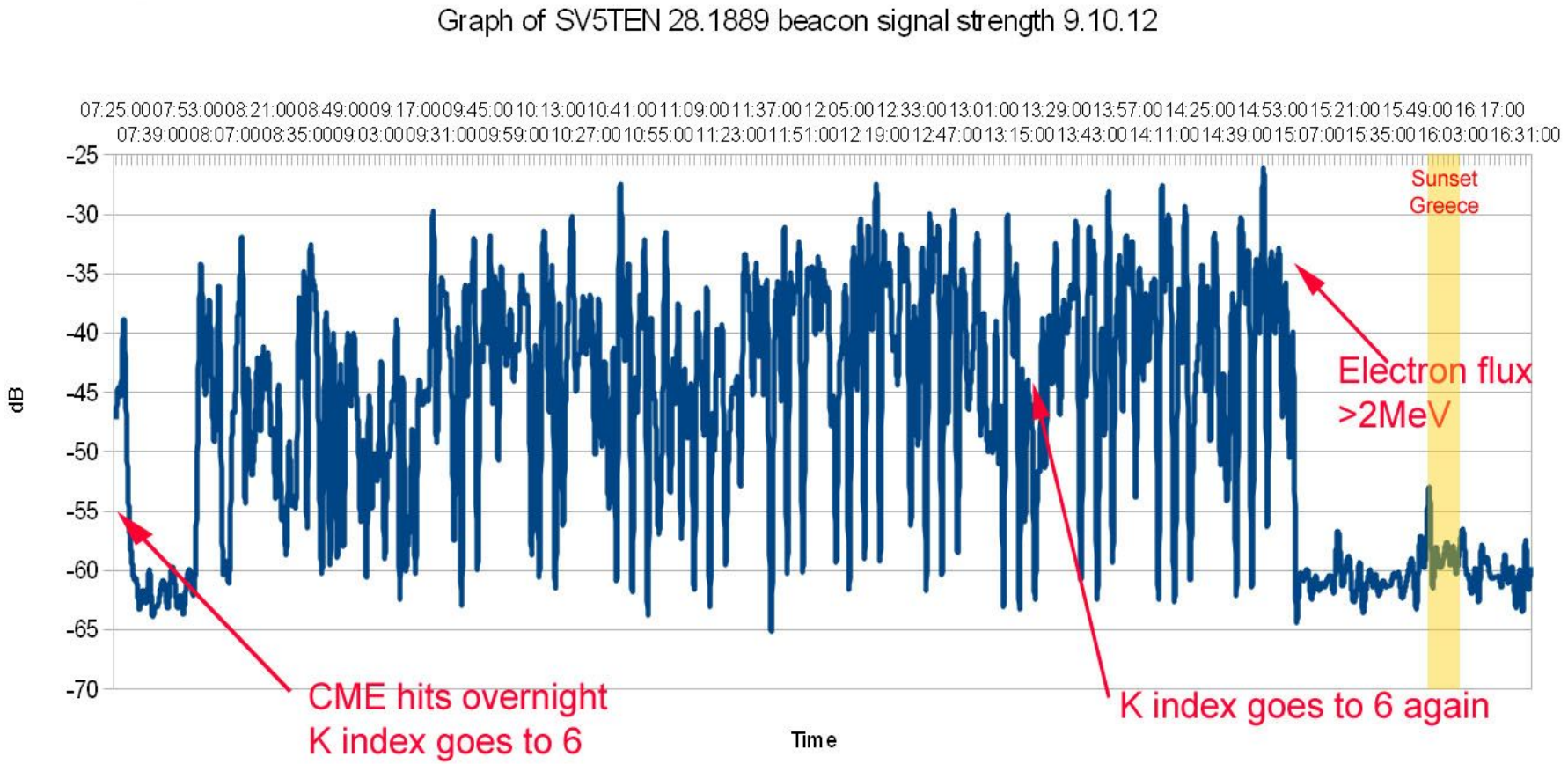
A word of caution!



Prediction programs offer a guide only

A word of caution!

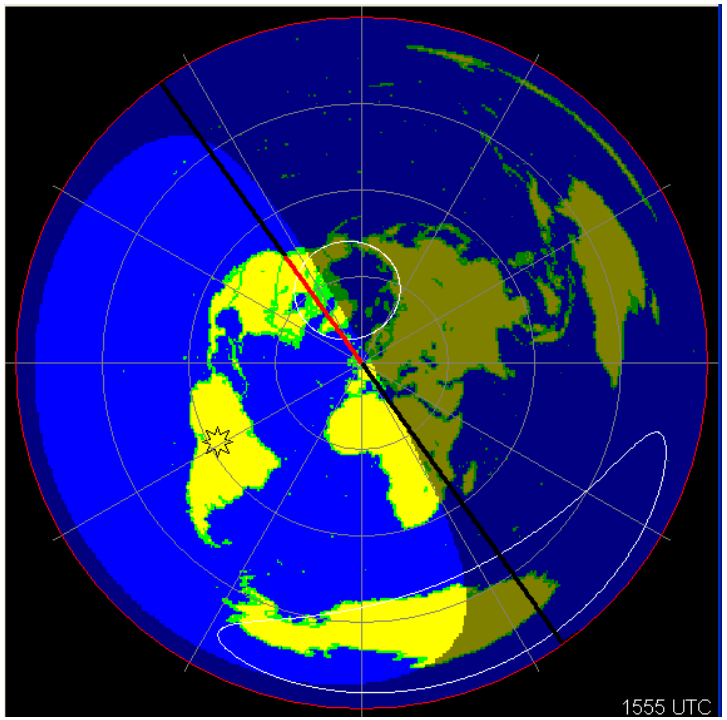


Reality is usually more complex ….

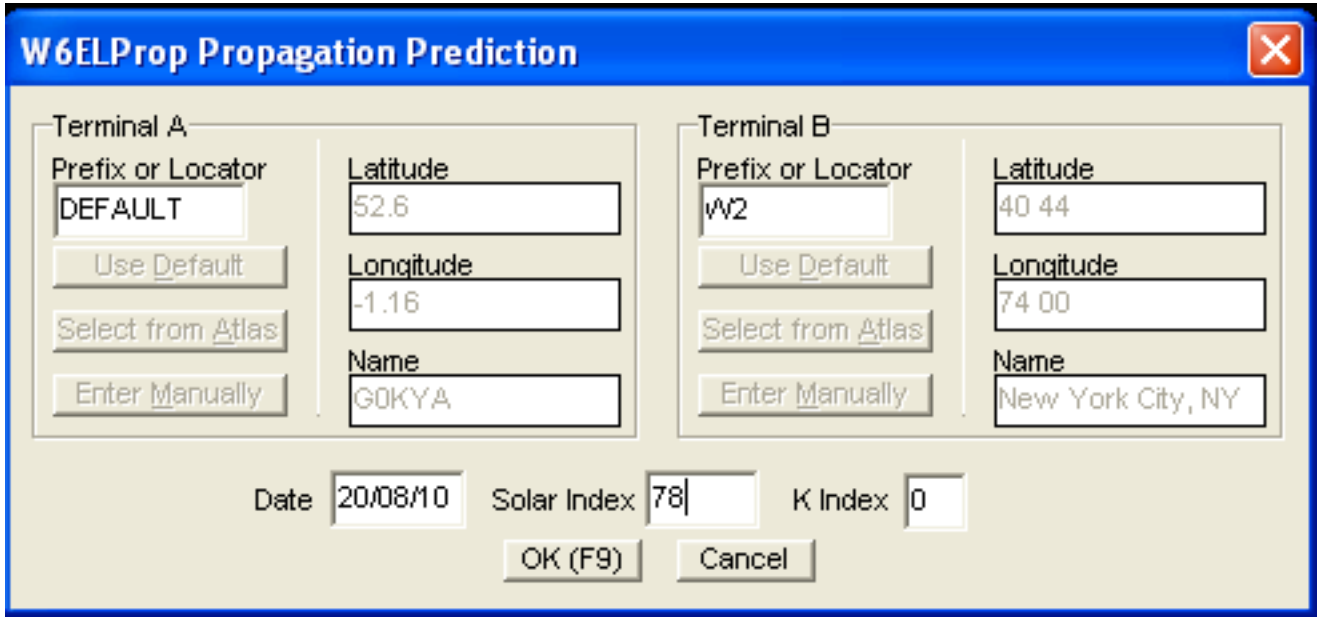
W6ELProp

- Free – getting a little old now, but very good and better at predicting 80m openings than VOACAP-derived programs.

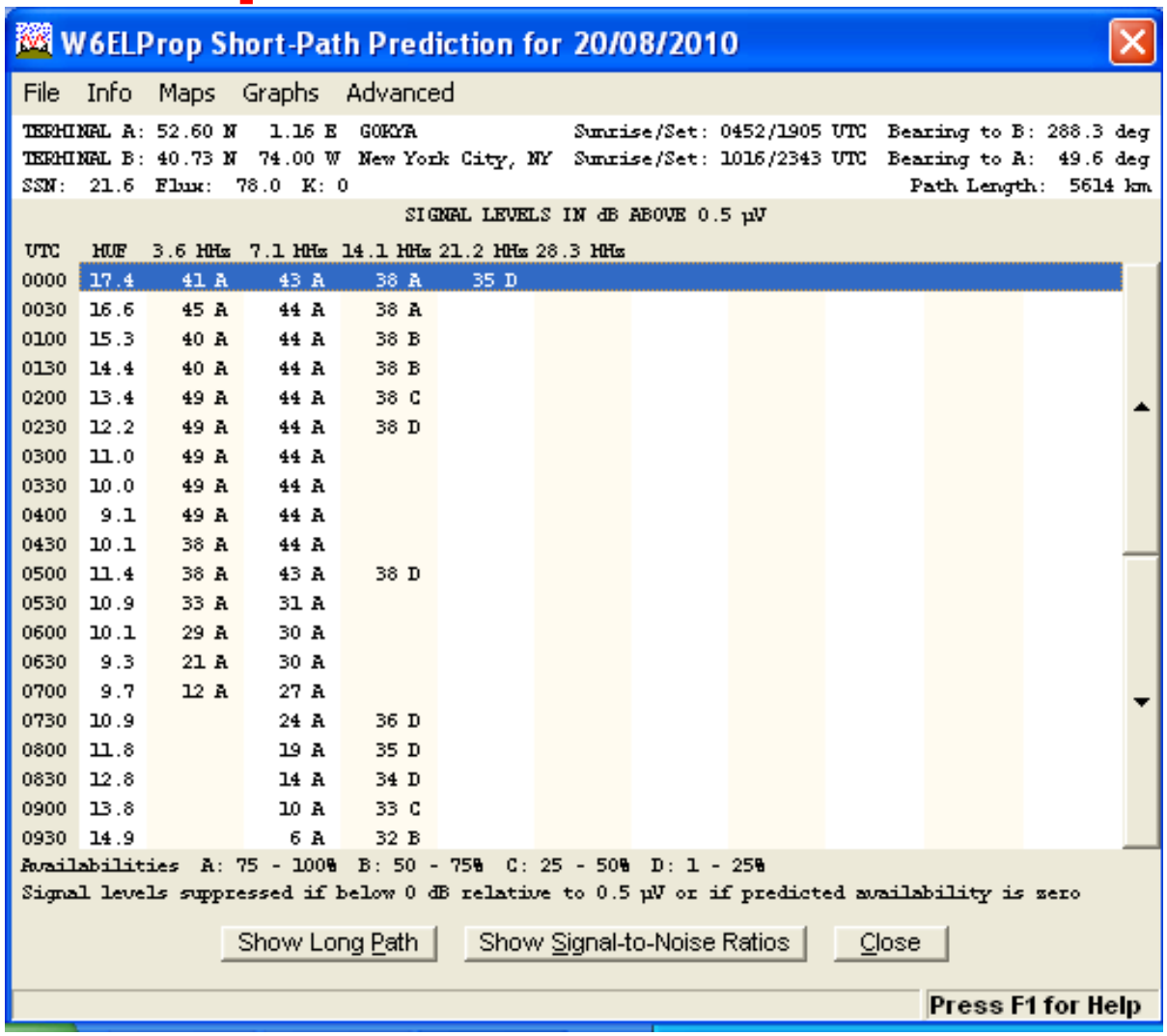
- See www.qsl.net/w6elprop/



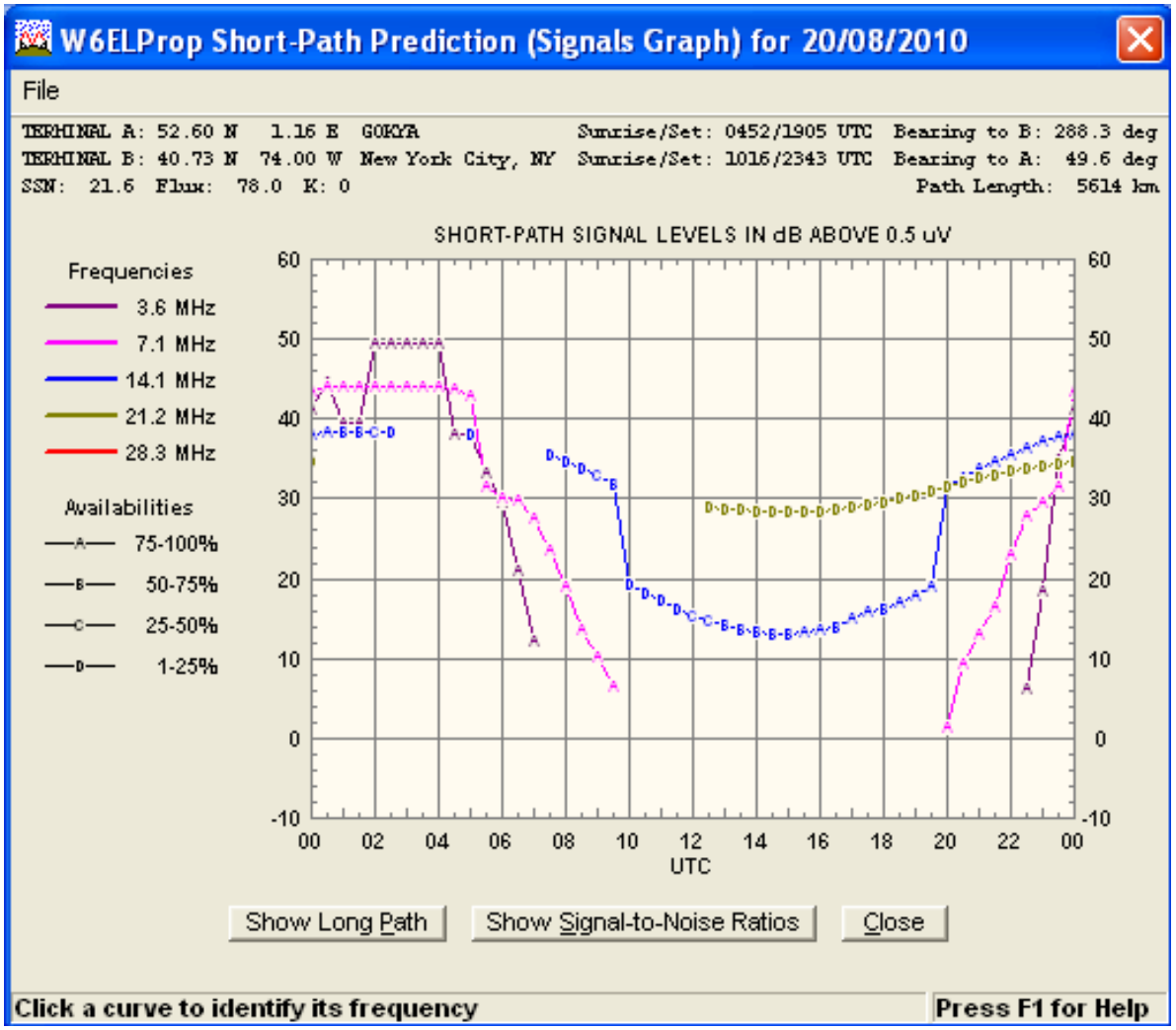
W6ELProp


W6ELProp Propagation Prediction
Terminal A
Prefix or Locator
DEFAULT
Use Default
Select from Atlas
Enter Manually
Latitude
52.6
Longitude
-1.16
Name
G0KYA
Terminal B
Prefix or Locator
W2
Use Default
Select from Atlas
Enter Manually
Latitude
40 44
Longitude
74 00
Name
New York City, NY
Date
20/08/10
Solar Index
78
K Index
0
OK (F9)
Cancel

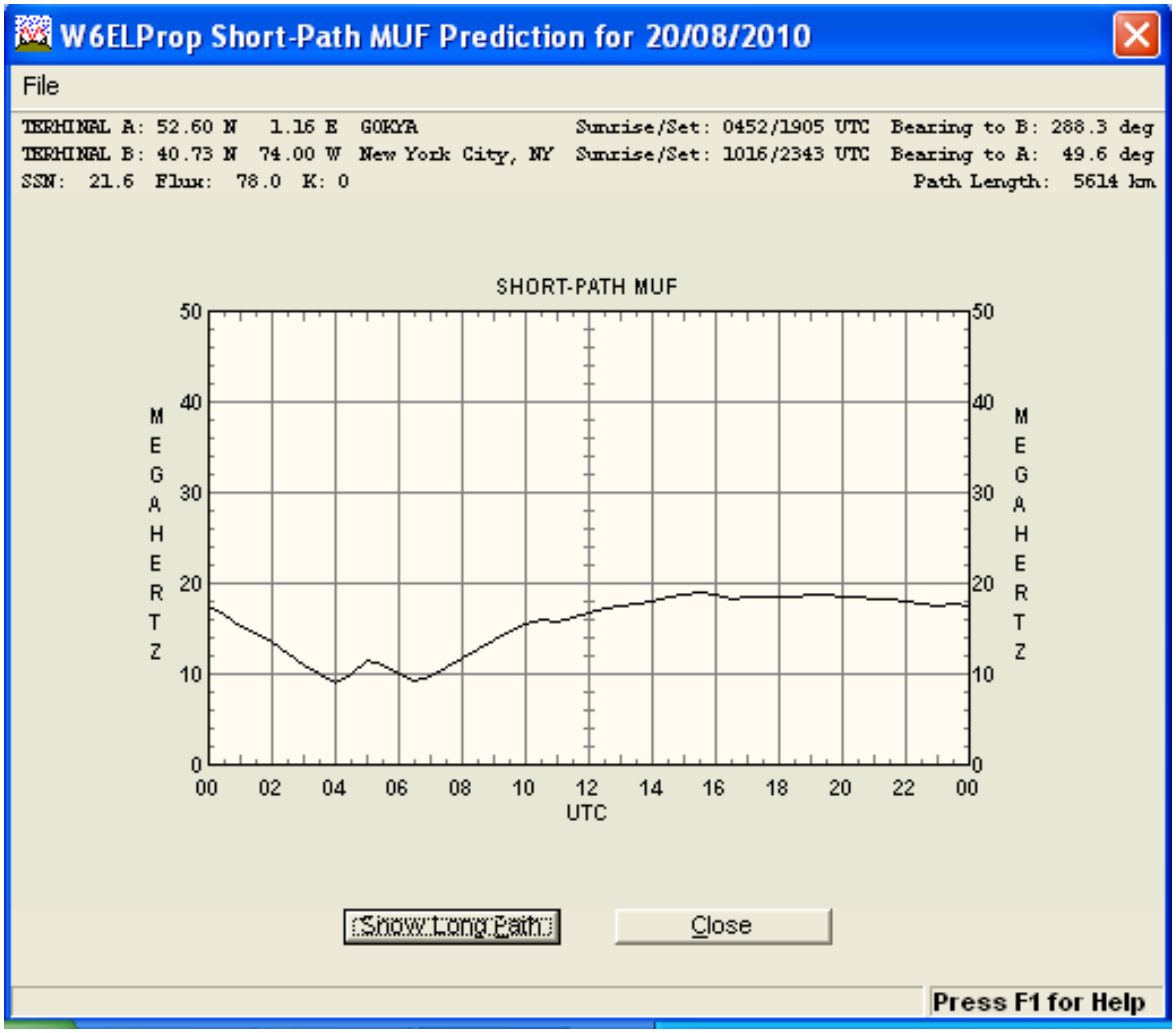
W6ELProp


W6ELProp Short-Path Prediction for 20/08/2010
File Info Maps Graphs Advanced
TERMINAL A: 52.60 N 1.16 E GOKYA Sunrise/Set: 0452/1905 UTC Bearing to B: 288.3 deg
TERMINAL B: 40.73 N 74.00 W New York City, NY Sunrise/Set: 1016/2343 UTC Bearing to A: 49.6 deg
SSN: 21.6 Flux: 78.0 K: 0 Path Length: 5614 km
SIGNAL LEVELS IN dB ABOVE 0.5 µV
UTC MUF 3.6 MHz 7.1 MHz 14.1 MHz 21.2 MHz 28.3 MHz
0000 17.4 41 A 43 A 38 A 35 D
0030 16.6 45 A 44 A 38 A
0100 15.3 40 A 44 A 38 B
0130 14.4 40 A 44 A 38 B
0200 13.4 49 A 44 A 38 C
0230 12.2 49 A 44 A 38 D
0300 11.0 49 A 44 A
0330 10.0 49 A 44 A
0400 9.1 49 A 44 A
0430 10.1 38 A 44 A
0500 11.4 38 A 43 A 38 D
0530 10.9 33 A 31 A
0600 10.1 29 A 30 A
0630 9.3 21 A 30 A
0700 9.7 12 A 27 A
0730 10.9 24 A 36 D
0800 11.8 19 A 35 D
0830 12.8 14 A 34 D
0900 13.8 10 A 33 C
0930 14.9 6 A 32 B
Availabilities A: 75 - 100% B: 50 - 75% C: 25 - 50% D: 1 - 25%
Signal levels suppressed if below 0 dB relative to 0.5 µV or if predicted availability is zero
Show Long Path
Show Signal-to-Noise Ratios
Close
Press F1 for Help

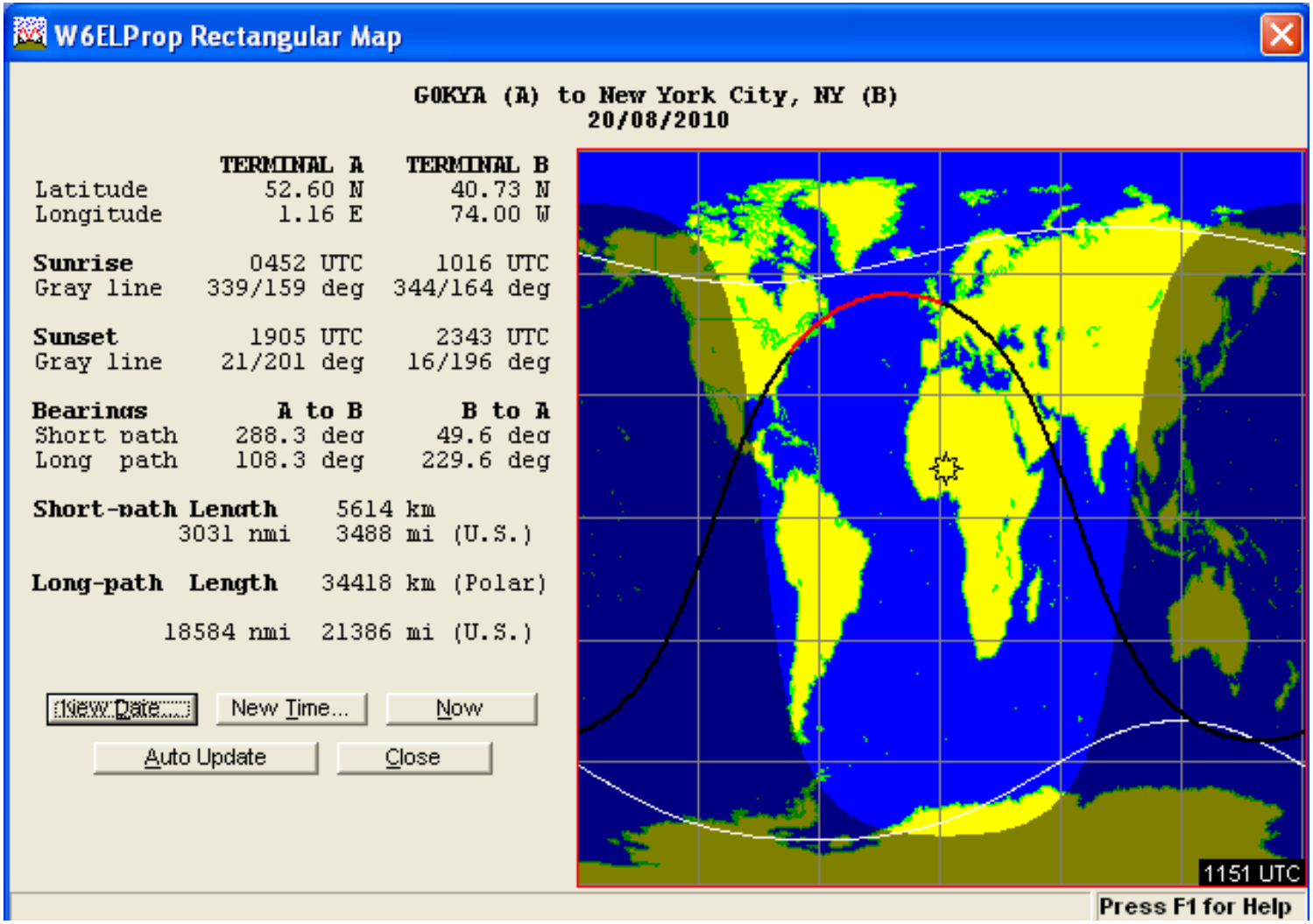
W6ELProp


W6ELProp Short-Path Prediction (Signals Graph) for 20/08/2010
File
TERMINAL A: 52.60 N 1.16 E G0KYA Sunrise/Set: 0452/1905 UTC Bearing to B: 288.3 deg
TERMINAL B: 40.73 N 74.00 W New York City, NY Sunrise/Set: 1016/2343 UTC Bearing to A: 49.6 deg
SSN: 21.6 Flux: 78.0 K: 0 Path Length: 5614 km
SHORT-PATH SIGNAL LEVELS IN dB ABOVE 0.5 uV
Frequencies
3.6 MHz
7.1 MHz
14.1 MHz
21.2 MHz
28.3 MHz
Availabilities
A 75-100%
B 50-75%
C 25-50%
D 1-25%
60
50
40
30
20
10
0
-10
00 02 04 06 08 10 12 14 16 18 20 22 00
UTC
Show Long Path
Show Signal-to-Noise Ratios
Close
Click a curve to identify its frequency
Press F1 for Help

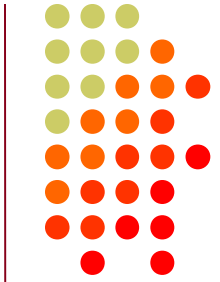
W6ELProp


W6ELProp Short-Path MUF Prediction for 20/08/2010
File
TERMINAL A: 52.60 N 1.16 E GOKYA Sunrise/Set: 0452/1905 UTC Bearing to B: 288.3 deg
TERMINAL B: 40.73 N 74.00 W New York City, NY Sunrise/Set: 1016/2343 UTC Bearing to A: 49.6 deg
SSN: 21.6 Flux: 78.0 K: 0 Path Length: 5614 km
SHORT-PATH MUF
MEGAHERTZ
0
10
20
30
40
50
00
02
04
06
08
10
12
14
16
18
20
22
00
UTC
Show Long Path
Close
Press F1 for Help

W6ELProp


W6ELProp Rectangular Map
G0KYA (A) to New York City, NY (B)
20/08/2010
TERMINAL A TERMINAL B
Latitude 52.60 N 40.73 N
Longitude 1.16 E 74.00 W
Sunrise 0452 UTC 1016 UTC
Gray line 339/159 deg 344/164 deg
Sunset 1905 UTC 2343 UTC
Gray line 21/201 deg 16/196 deg
Bearings A to B B to A
Short path 288.3 deg 49.6 deg
Long path 108.3 deg 229.6 deg
Short-path Length 5614 km
3031 nmi 3488 mi (U.S.)
Long-path Length 34418 km (Polar)
18584 nmi 21386 mi (U.S.)
New Date...
New Time...
Now
Auto Update
Close
1151 UTC
Press F1 for Help

VOACAP



- An industry standard and thought to be “one of the best”.
- Very complex and hard to use.
- Lots of parameters can be changed/need to be set up properly
- Good for point-point predictions
- Has to be installed before you can use some of the other programs like VOAProp.

- See www.voacap.com/

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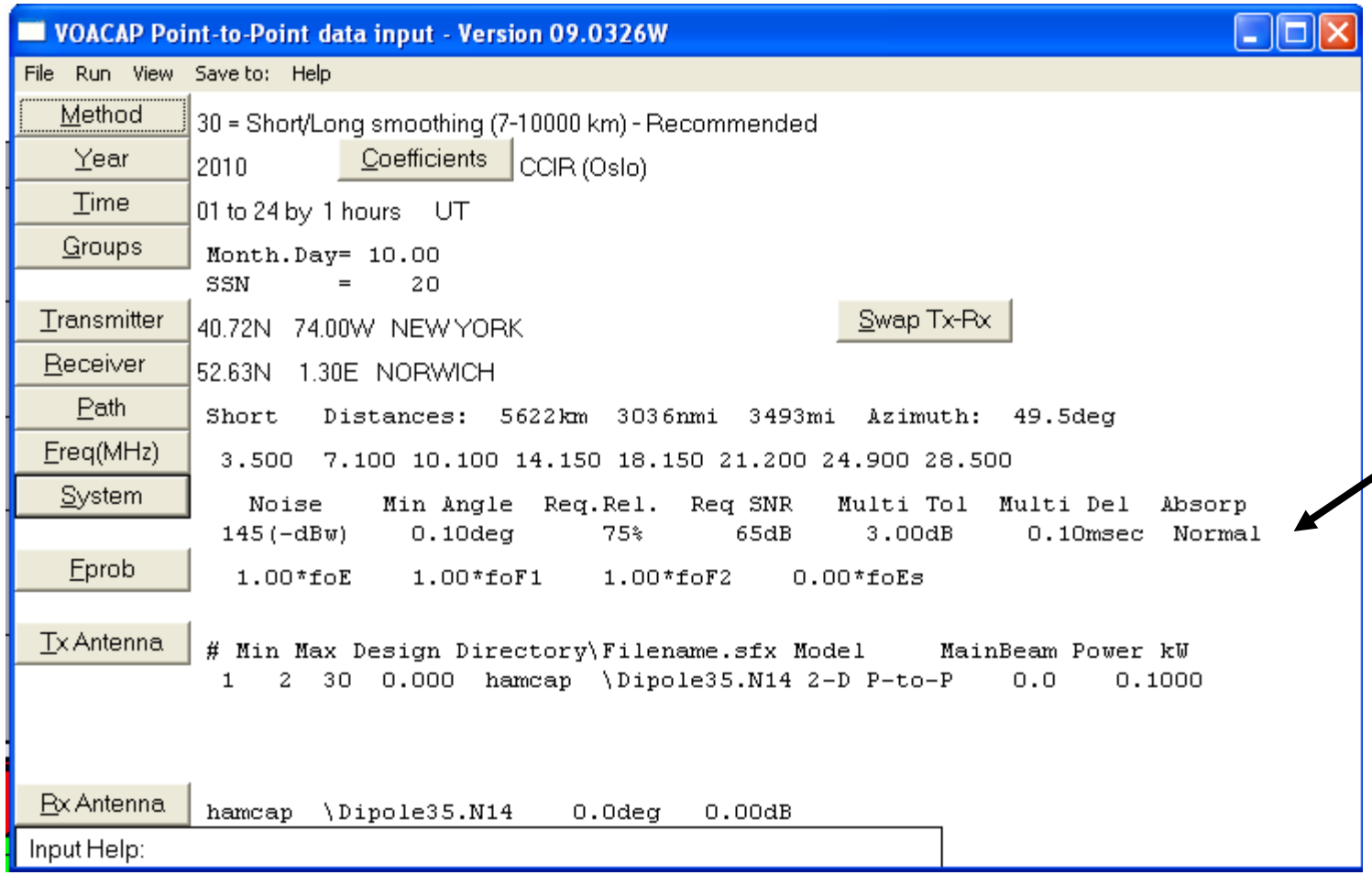
VOACAP



Critical! *

*** See http://www.astrosurf.com/luxorion/qsl-soft-voacap3.htm and use smoothed sunspot numbers:**

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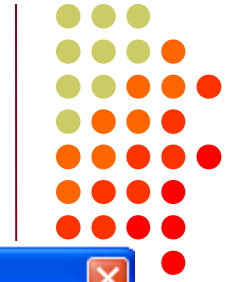
VOACAP



Select PARAMETER to plot from: Group # 1 10.00 20ssn

Exit

Group # 1 10.00 20ssn

Parameter	[Minimum/Maximum]
TANGLE= Radiation angle (degrees)	[0.70/ 19.00]
DELAY = Time delay (milliseconds)	[18.90/ 21.00]
VHITE = Virtual height (km)	[81.00/ 452.00]
MUFday= % of days/month sky-wave propagation expected at MUF	[0.00/ 100.00]
LOSS = Median system loss (dB)	[151.00/ 502.00]
DBU = Median field strength at receive location (dBu)	[-351.00/ 0.00]
SDBW = Median signal power at receiver (dBW)	[-482.00/-124.00]
NDBW = Median noise power at receiver (dBW)	[-173.00/-137.00]
SNR = Median signal-to-noise ratio (dB)	[-310.00/ 32.00]
RPWRG = Required power & antenna gain to achieve reliab (dB)	[67.00/ 400.00]
REL = Time availability, % time SNR exceeds required SNR	[0.00/ 0.00]
MPROB = Probability additional mode in multipath tolerances	[0.00/ 0.00]
SPRB = Service probability, required reliabilty will be met	[0.00/ 3.00]
SIGLW = Lower decile signal pwr (field strength & loss) (dB)	[8.40/ 25.00]
SIGUP = Upper decile signal pwr (field strength & loss) (dB)	[0.90/ 25.00]
SNRLW = Lower decile SNR increment (dB)	[12.70/ 26.80]
SNRUP = Upper decile SNR increment (dB)	[6.00/ 25.70]
TGAIN = Transmitter Antenna Gain (dB)	[-30.00/ 7.10]
RGAIN = Receiver Antenna Gain (dB)	[-30.00/ 7.10]
SNRxx = Signal-to-Noise ratio (dB) at Req. Rel.	[-327.00/ 6.00]

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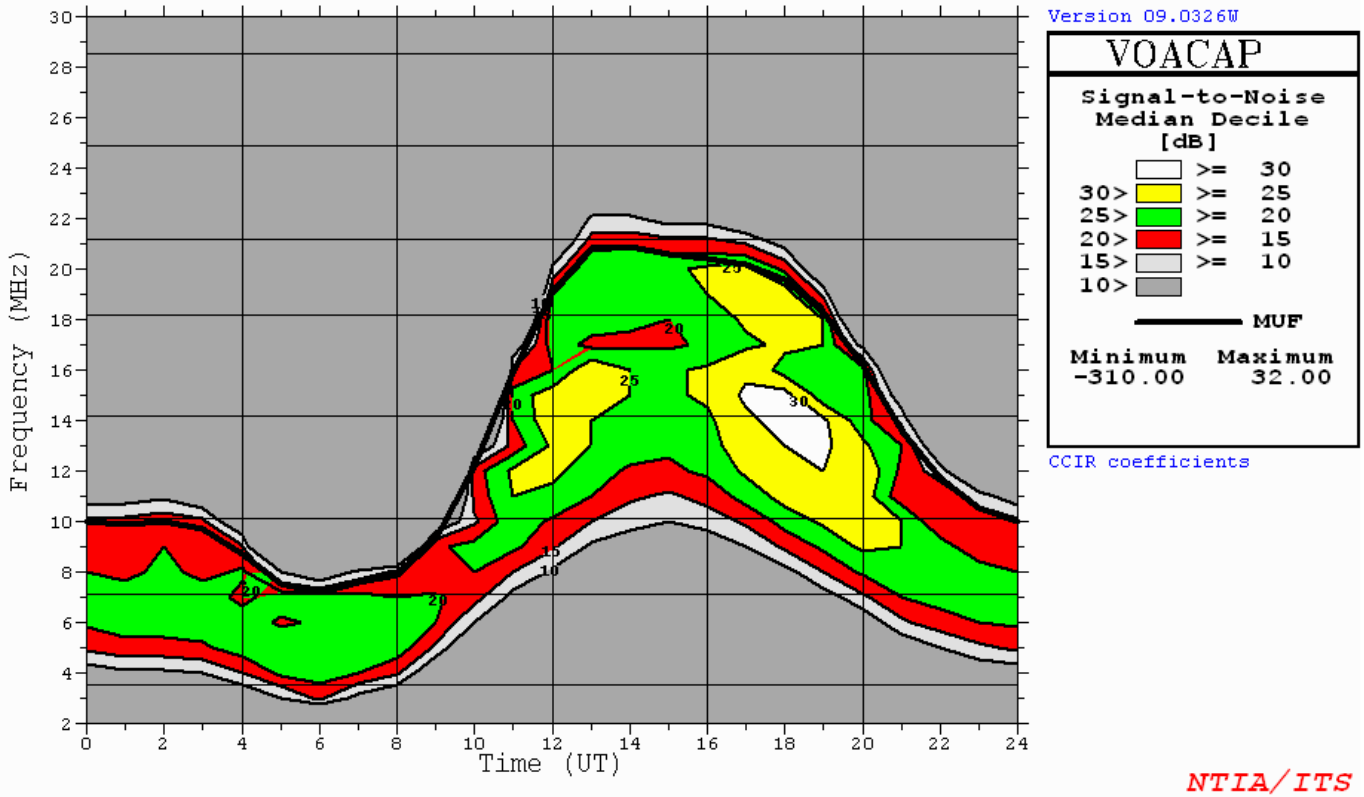
VOACAP

```
Oct     2010          SSN =  20.                Minimum Angle= 0.100 degrees
NEW YORK            NORWICH              AZIMUTHS          N. MI.      KM
40.72 N   74.00 W - 52.63 N    1.30 E     49.48  288.35    3035.8    5621.8
XMTR  2-30 2-D P-to-P[hamcap\Dipole35.N14  ] Az=  0.0 OFFaz= 49.5    0.100kW
RCVR  2-30 2-D P-to-P[hamcap\Dipole35.N14  ] Az=  0.0 OFFaz=288.4
3 MHz NOISE = -145.0 dBW     REQ. REL = 75%    REQ. SNR = 65.0 dB
MULTIPATH POWER TOLERANCE =  3.0 dB   MULTIPATH DELAY TOLERANCE =  0.100 ms
```



NTIA/ITS

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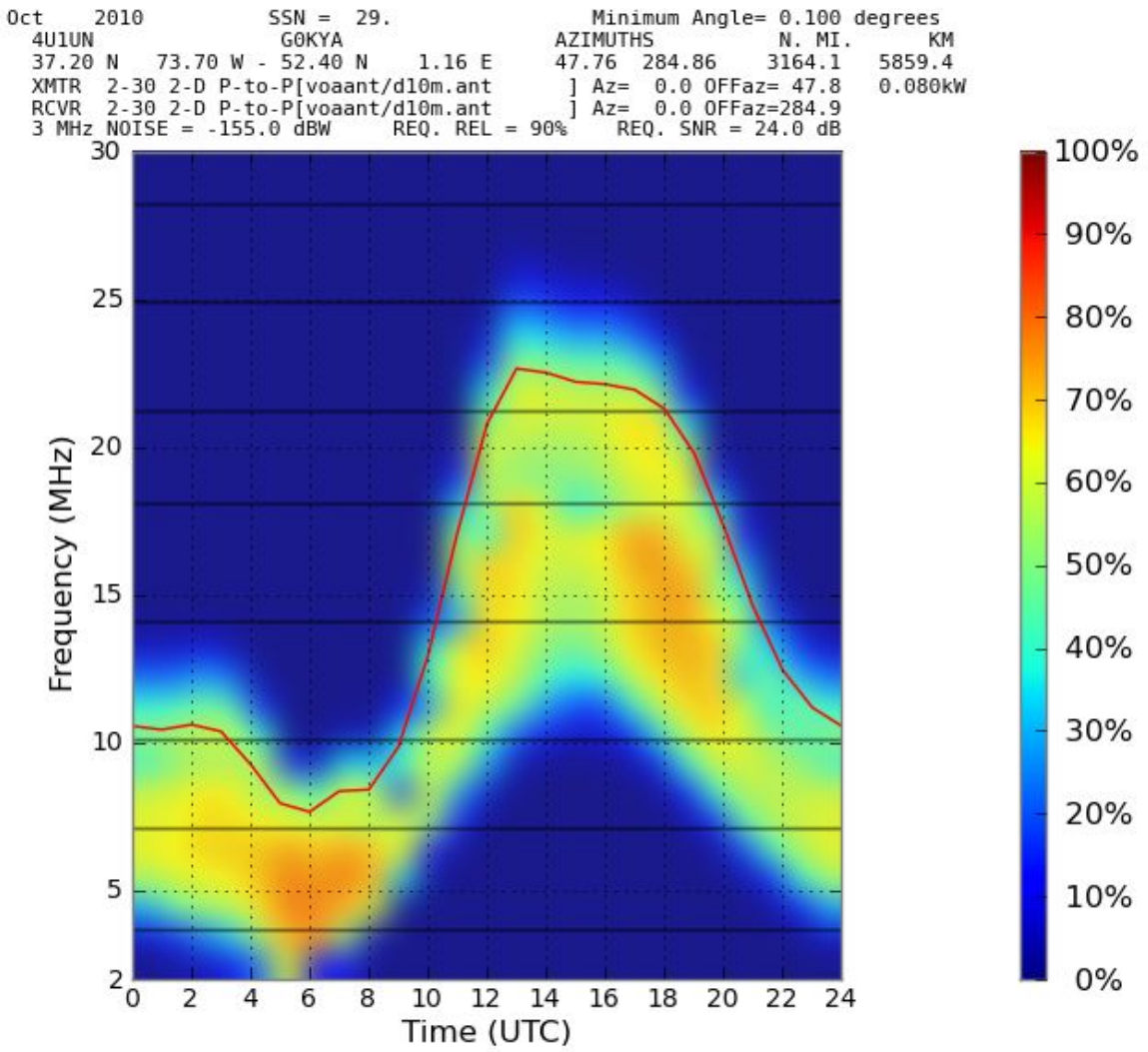
Circuit Reliability (%)



VOACAP Online – see
http://www.voacap.com/prediction.html

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VOAProp by G4ILO

- Free – fantastic attempt at putting a graphical interface on VOACAP.
- Can be adjusted easily to suit your station
- Shows IBP beacons
- Shows call areas
- Can be used for broadcast stations as well

See www.g4ilo.com/voaprop.html

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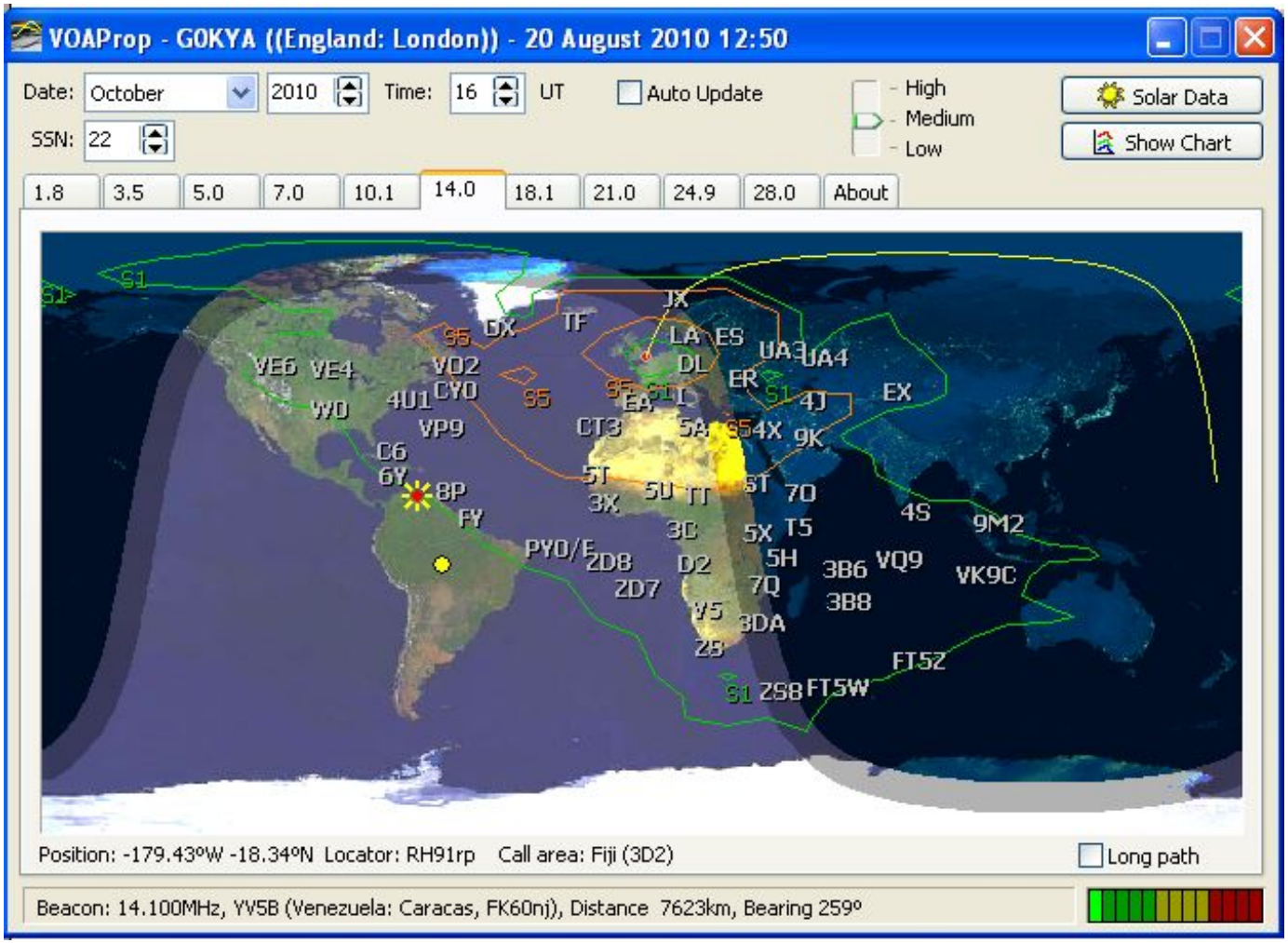
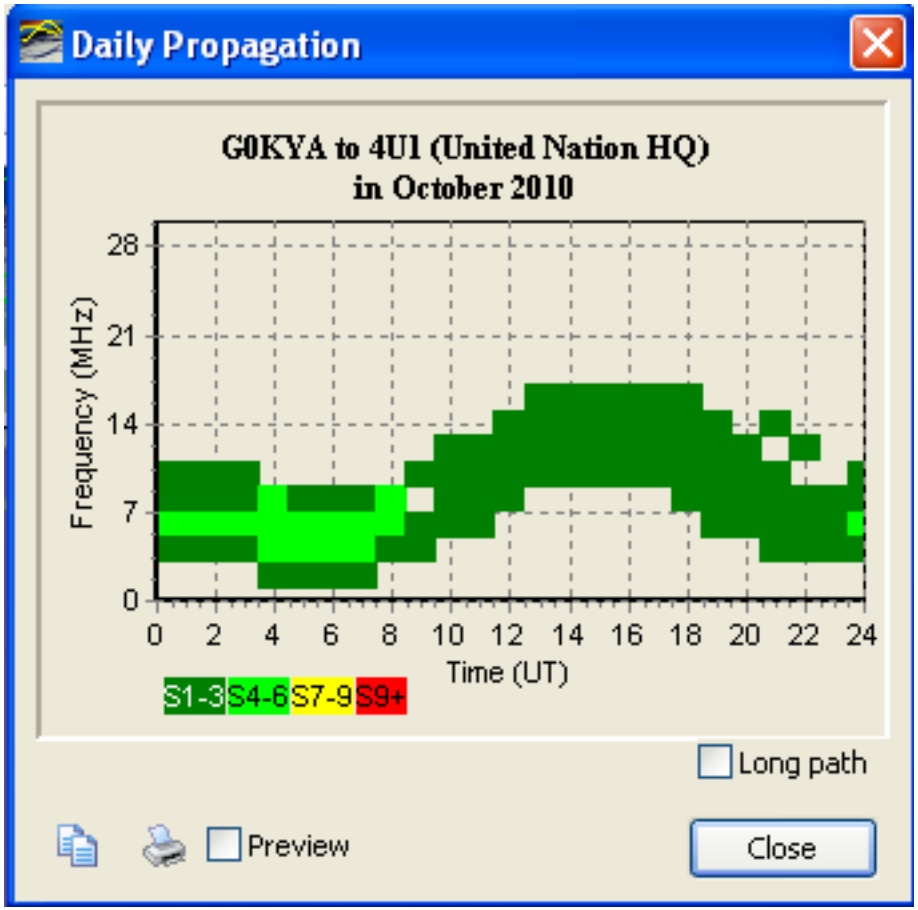
VOAProp by G4ILO

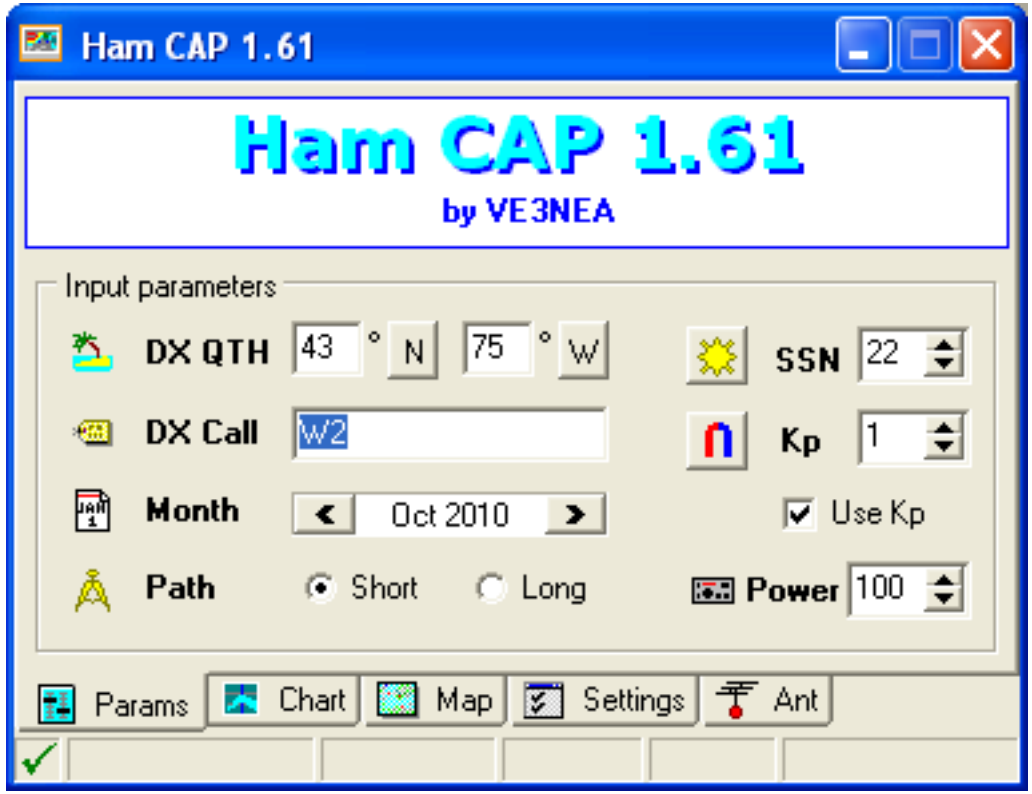


VOAProp by G4ILO

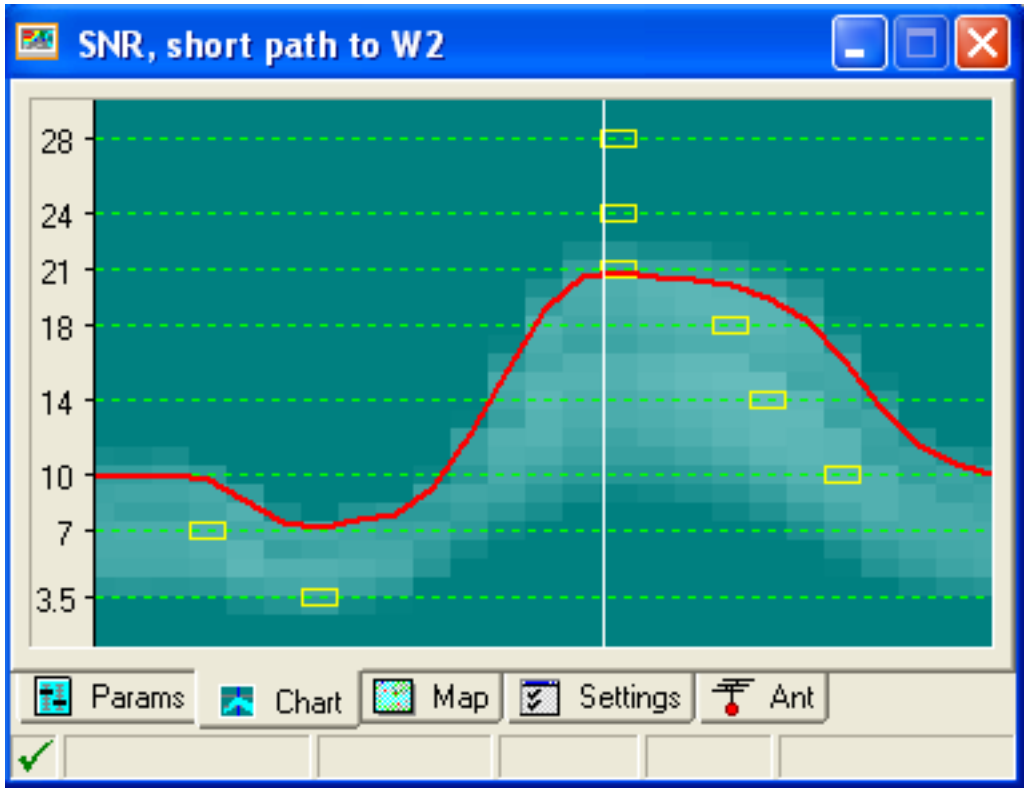


HamCAP by VE3NEA

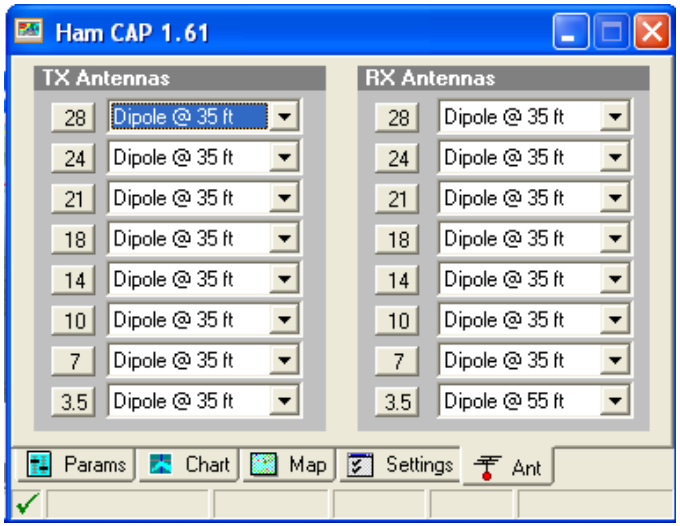
- Another free front-end for VOACAP
- Can also produce web pages
- Can work with DXAtlas
- Window is a little small and can't be resized.

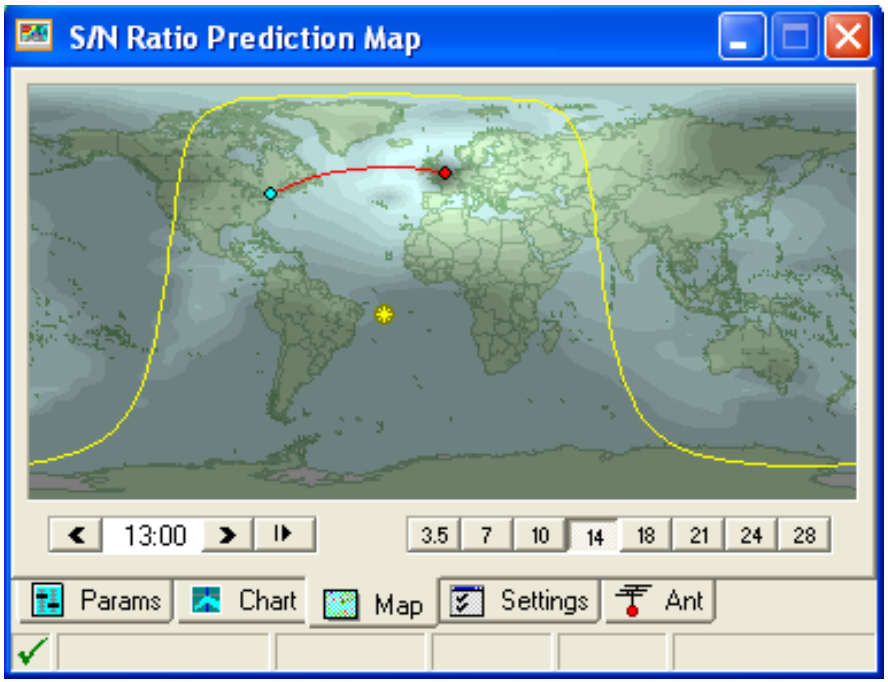


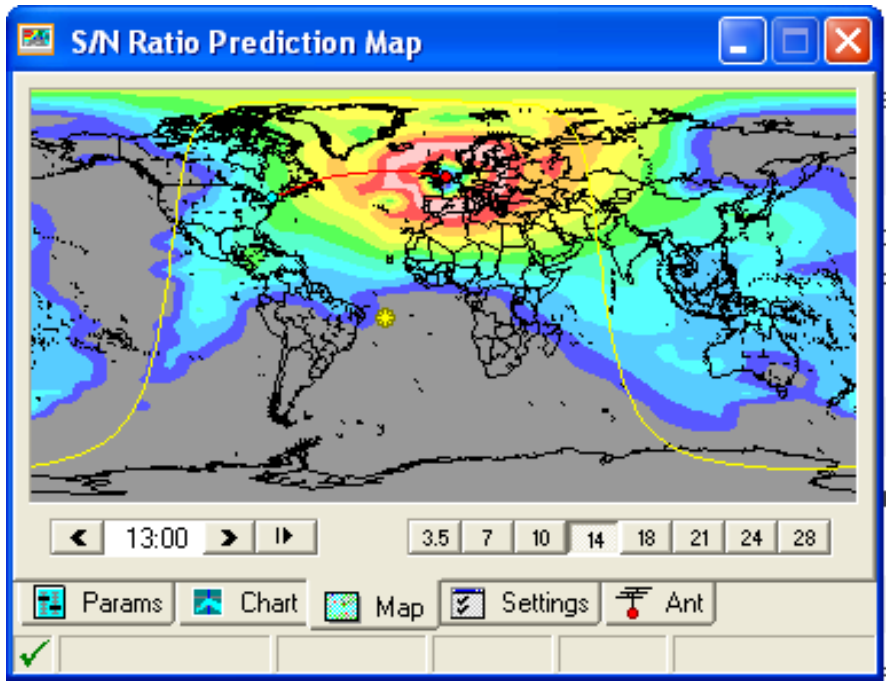
HamCAP by VE3NEA



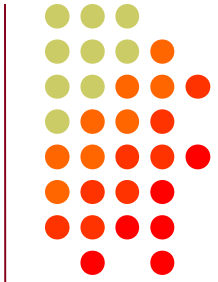
HamCAP by VE3NEA







WinCap Wizard by Taborsoft



- Free “lite” version– great graphical interface on VOACAP.
- Can be adjusted just like VOACAP
- Full version costs $50

See www.taborsoft.com/wwizard/

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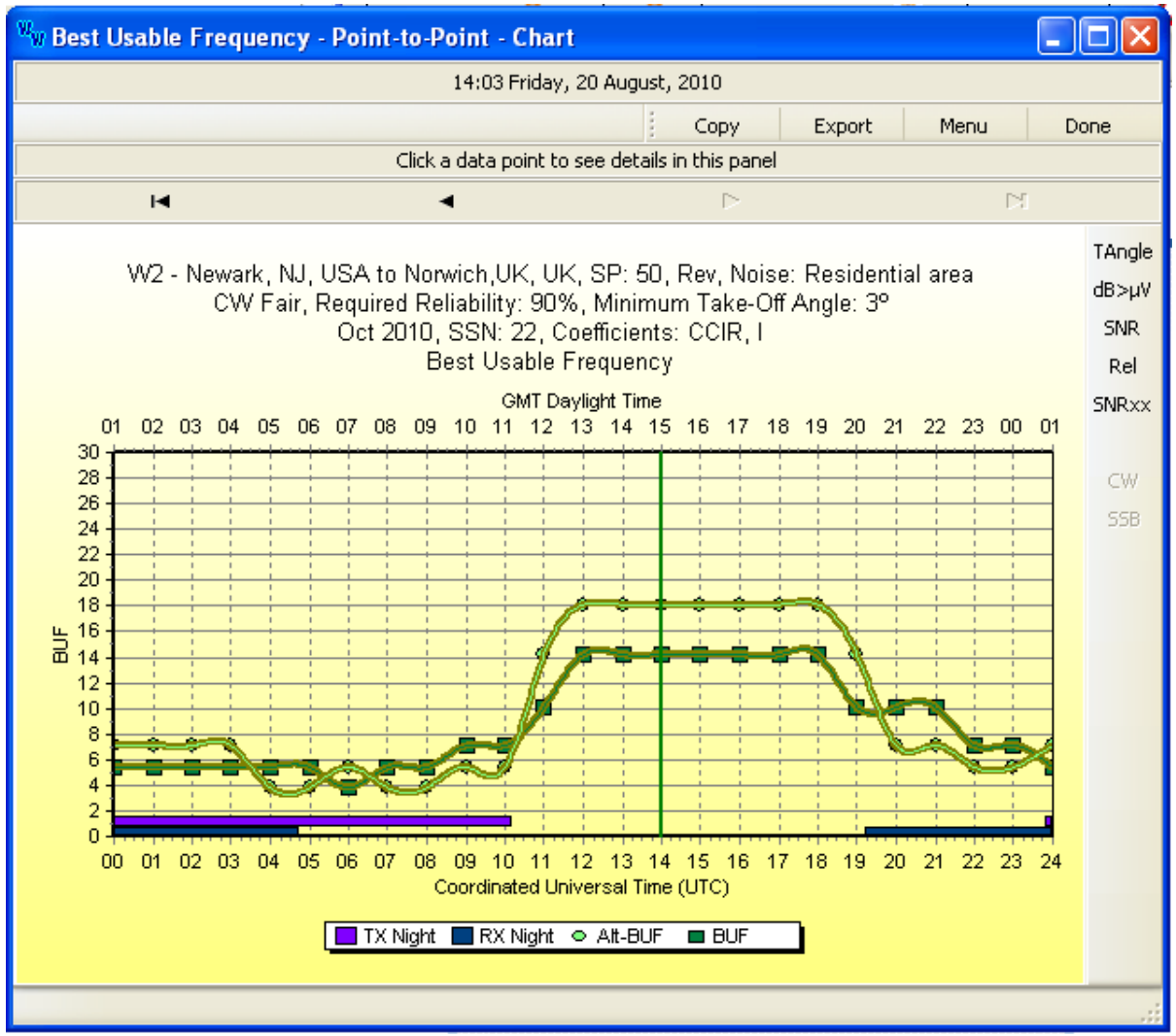
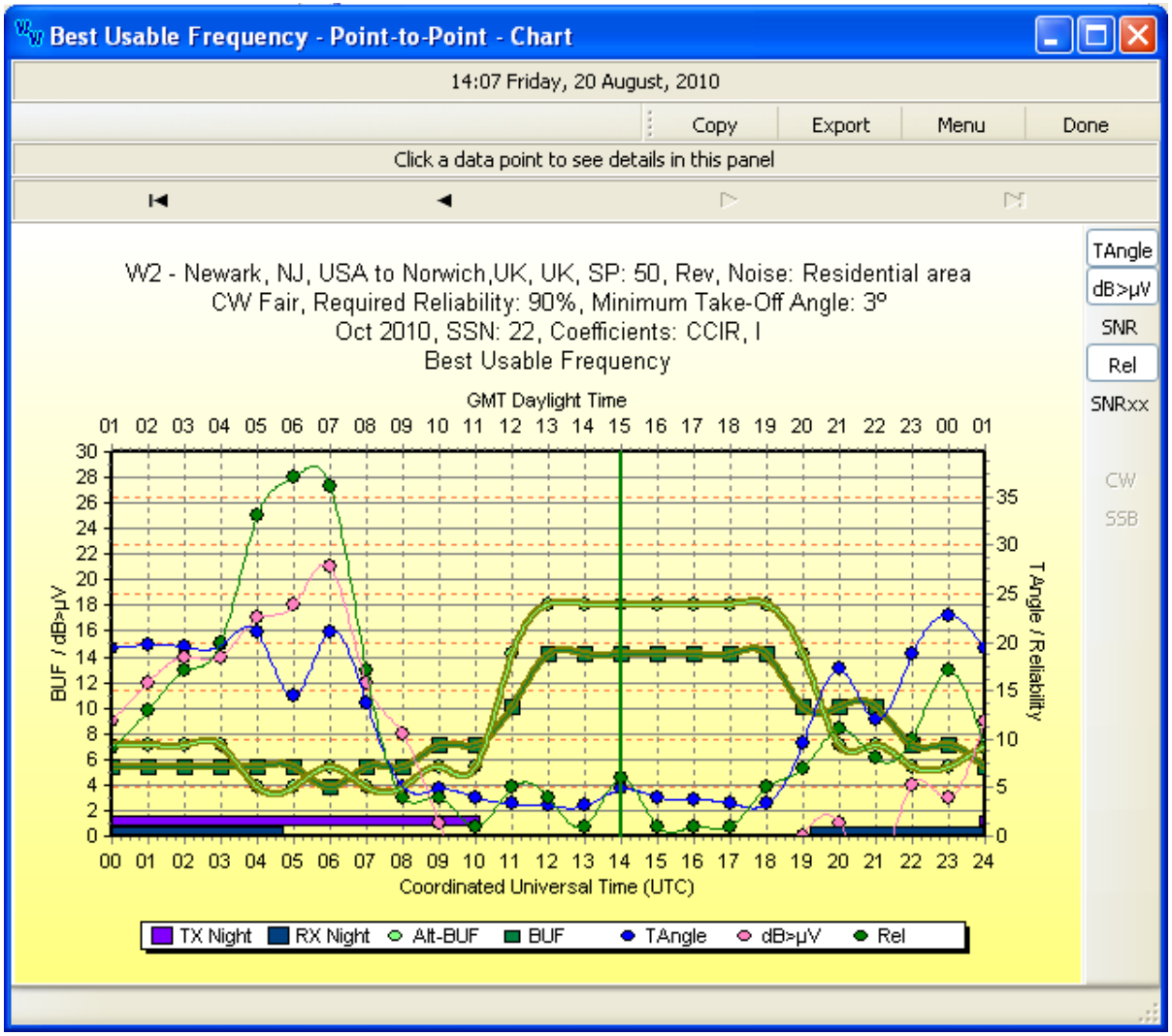
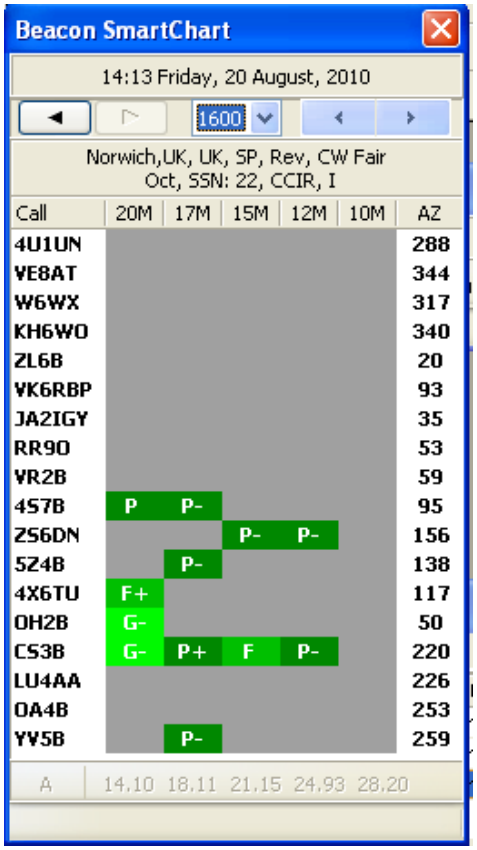
WinCap Wizard by Taborsoft



WinCap Wizard by Taborsoft





ACE-HF

- Costs $99
- Very good graphical representation of VOACAP
- Can handle beacons and “what’s open to where”

See http://www.hfradio.org/ace-hf/

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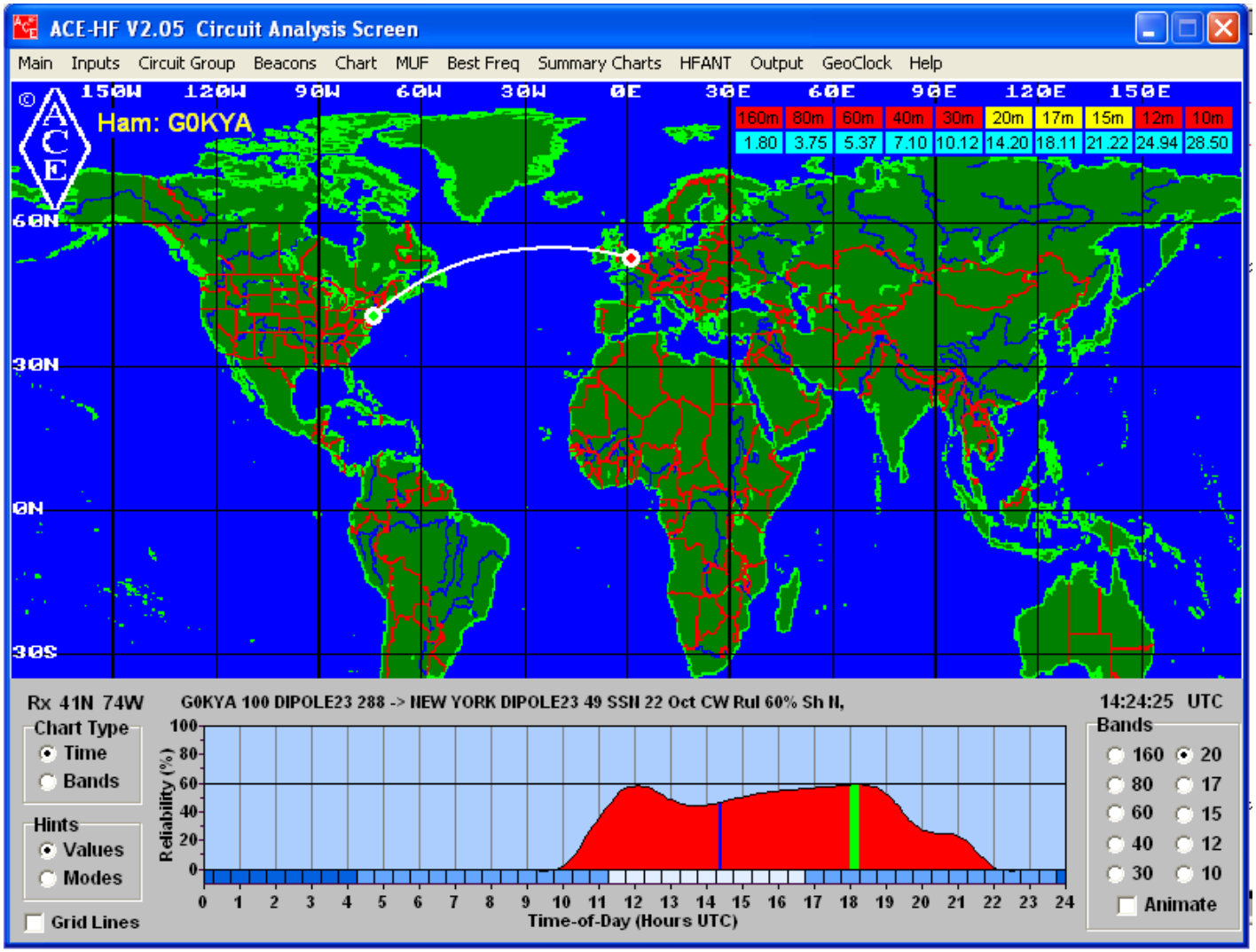
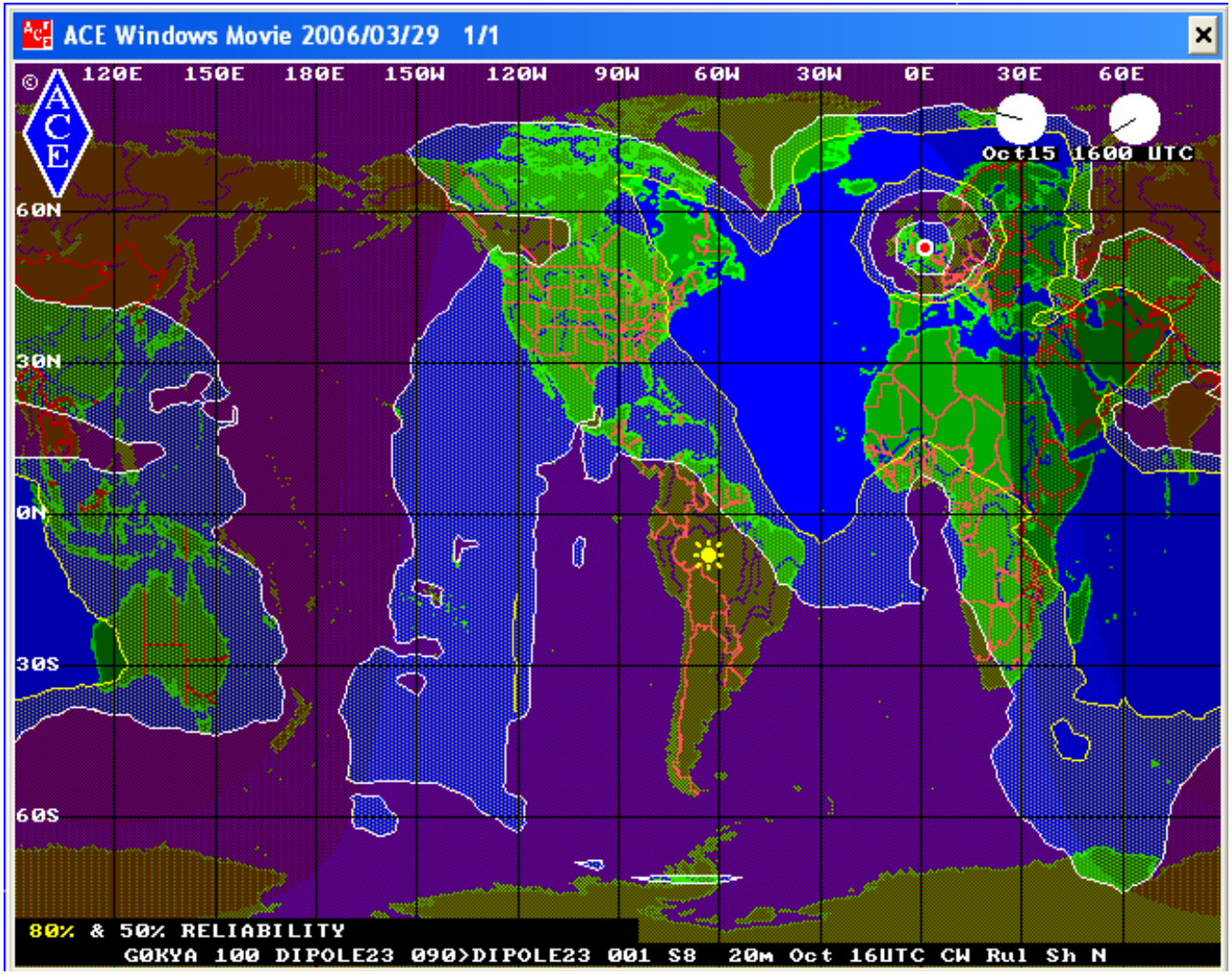
ACE-HF


ACE-HF V2.05 Circuit Analysis Screen
Main Inputs Circuit Group Beacons Chart MUF Best Freq Summary Charts HFANT Output GeoClock Help
150W 120W 90W 60W 30W 0E 30E 60E 90E 120E 150E
Ham: G0KYA
160m 80m 60m 40m 30m 20m 17m 15m 12m 10m
1.80 3.75 5.37 7.10 10.12 14.20 18.11 21.22 24.94 28.50
60N
30N
0N
30S
Rx 41N 74W
G0KYA 100 DIPOLE23 288 -> NEW YORK DIPOLE23 49 SSN 22 Oct CW Rul 60% Sh N,
14:24:25 UTC
Chart Type
Time
Bands
Hints
Values
Modes
Grid Lines
Reliability (%)
Time-of-Day (Hours UTC)
Bands
160 20
80 17
60 15
40 12
30 10
Animate

ICOM

ACE-HF


ACE Windows Movie 2006/03/29 1/1
120E 150E 180E 150W 120W 90W 60W 30W 0E 30E 60E
Oct15 1600 UTC
60N
30N
0N
30S
60S
80% & 50% RELIABILITY
G0KYA 100 DIPOLE23 090>DIPOLE23 001 S8 20m Oct 16UTC CW Rul Sh N

In conclusion …

- If doing contest planning ….

  …. Work out what band is open to where and when
  …. Produce print outs on an hour by hour, band by band basis.

- Failing that use a laptop or netbook

- For ease of use VOAProp will work well on site

In conclusion …

- Things to consider:

  - The gain of your/other's antenna + power

  - Greyline openings

  - Sporadic E

  - Top Band openings

  - Changing ionospheric/solar conditions during the contest

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