HF Propagation and Software

RSGB Hamfest, Newark 2010

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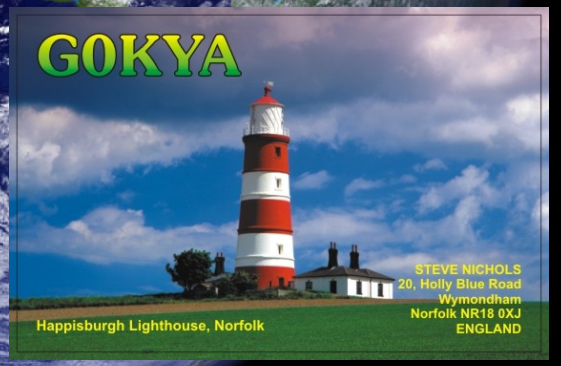
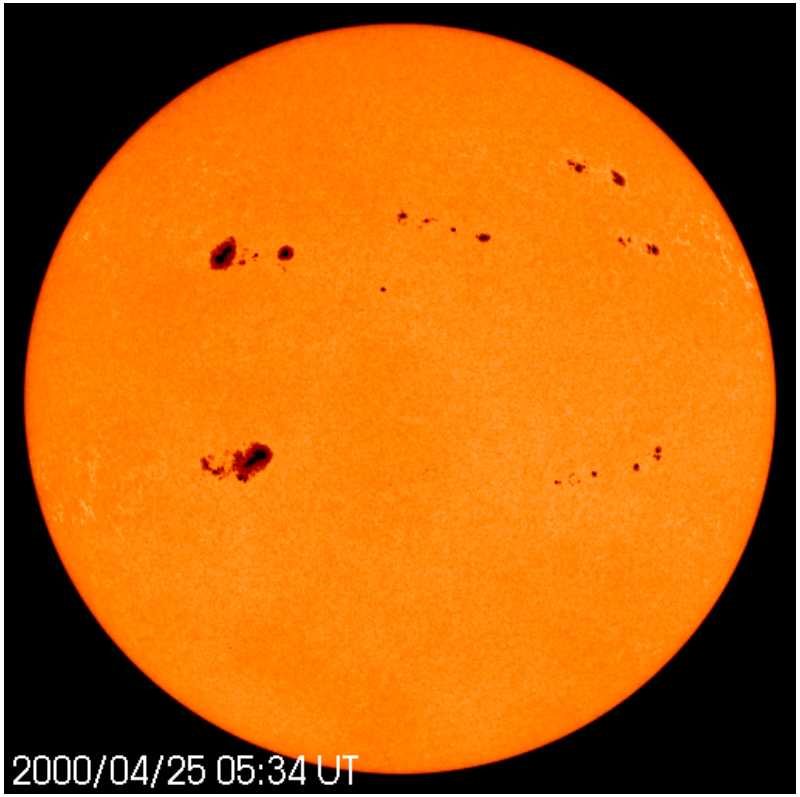
www.qsl.net/g0kya



A brief run down on solar physics

- The sun emits massive amounts of electromagnetic ionising radiation (inc. UV/X rays)
- Put simplistically, the more sunspots, the more ionisation.
- We measure the solar output at 2.8GHz (10.7cm) to give us a “solar flux” figure



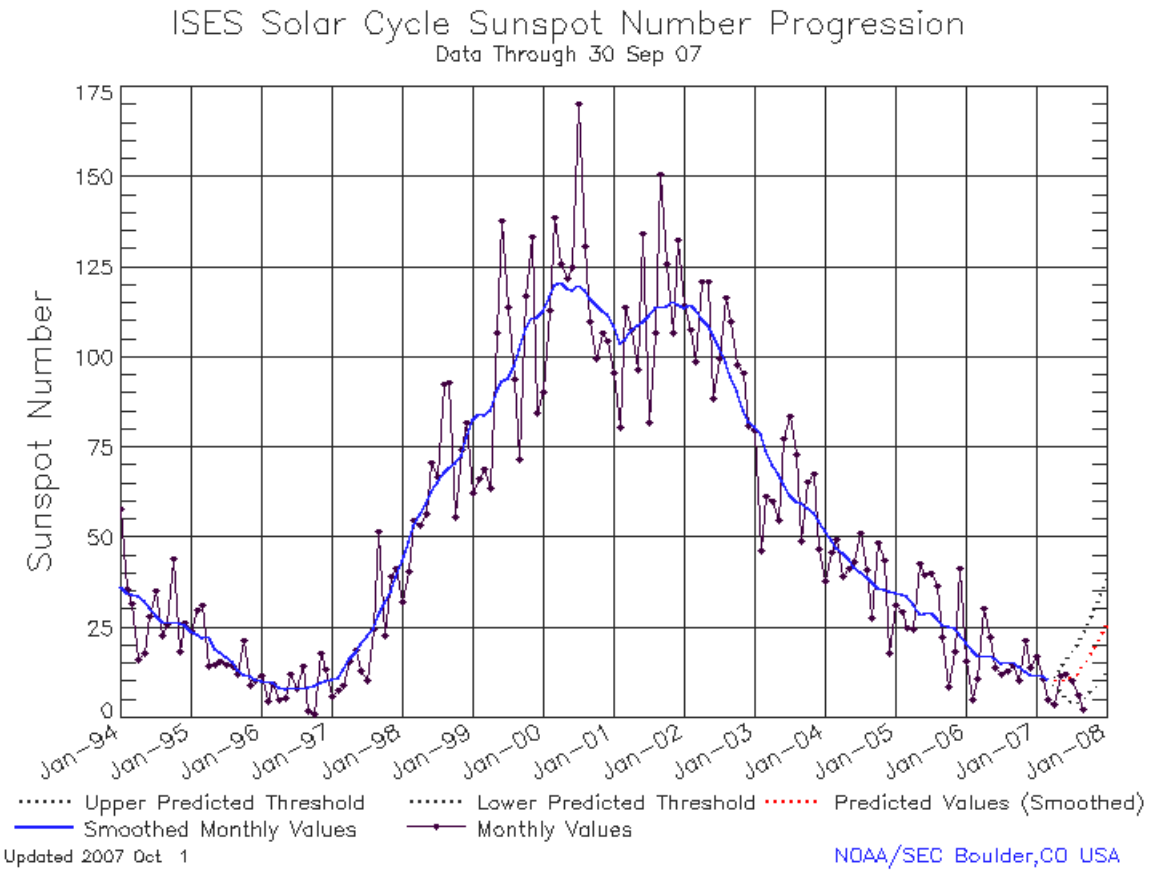
A brief run down on solar physics

- The solar flux can be as low as 65 (2008)

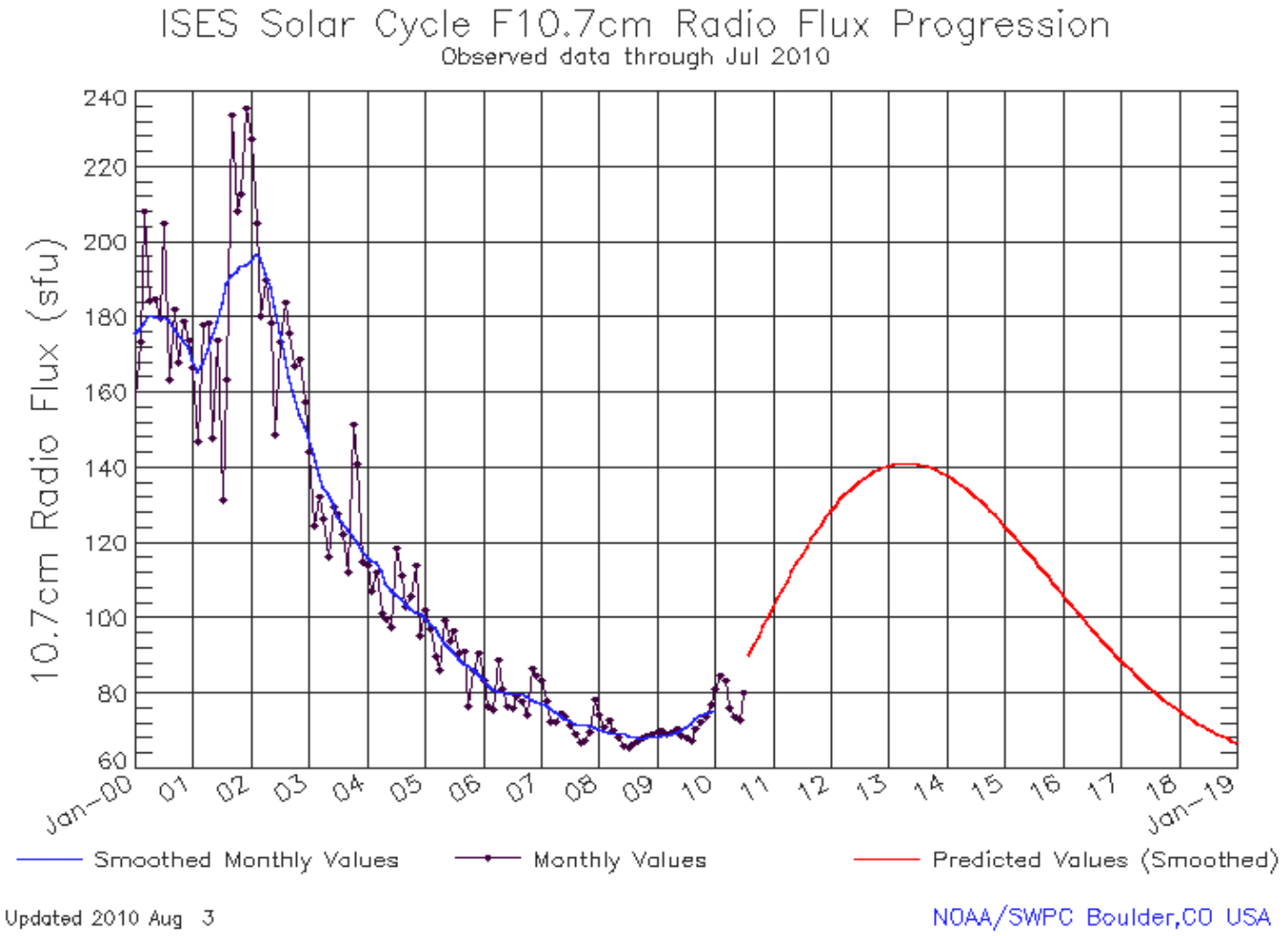
or as high as 274 (2001)

Even up to 300

Wolf Sunspot Number formula R = k(10g + s), where g is the number of sunspot groups (regions), s is the total number of individual spots.

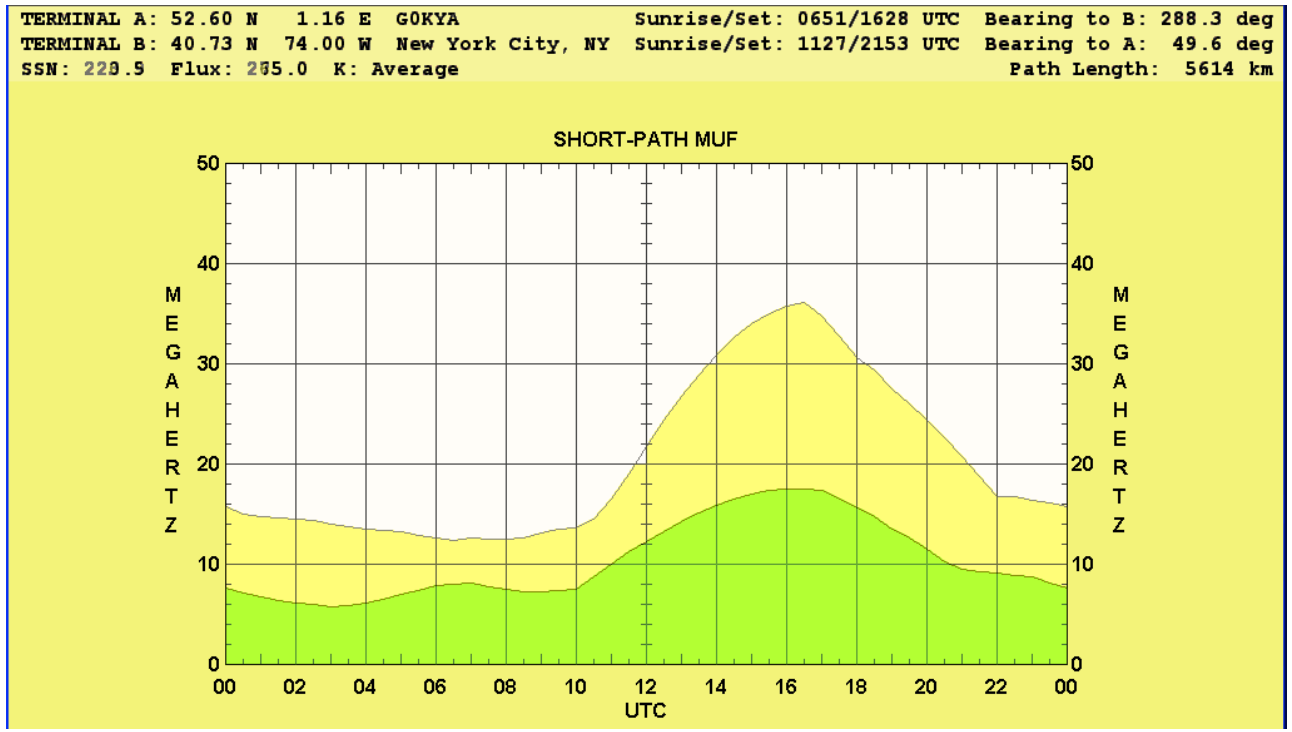


A brief run down on solar physics



Where are we we in the cycle?

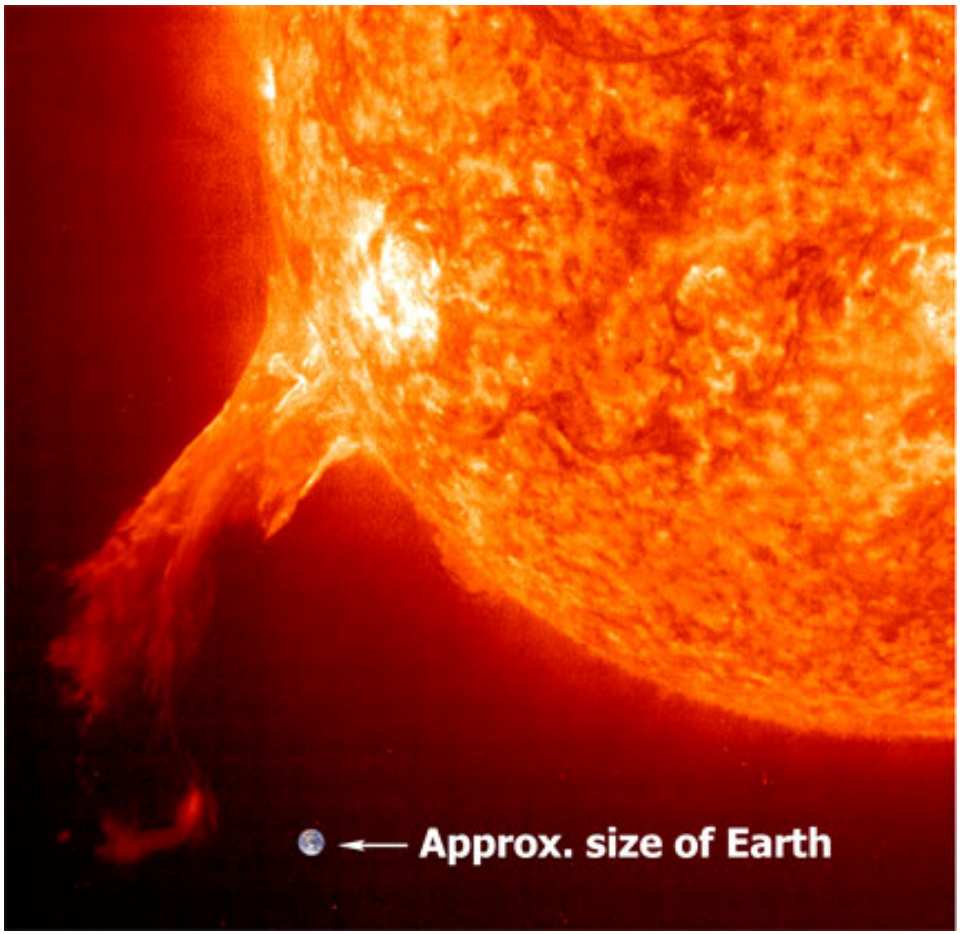
A brief run down on solar physics



- MUF between G and New York in October for solar flux levels of 65 and 275. It varies dramatically.

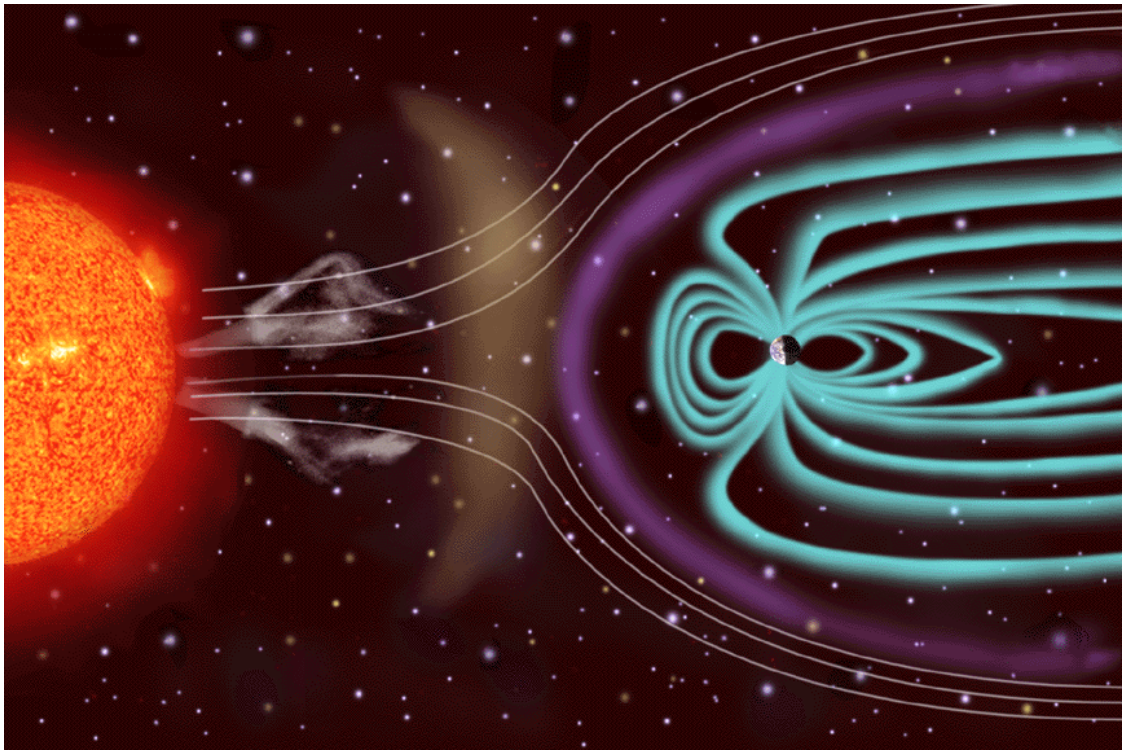
A brief run down on solar physics

- The sun also emits massive clouds of charged particles via solar flares and coronal mass ejections /coronal holes



A brief run down on solar physics

- These can head towards the earth, where the particles can be channelled towards the poles
- This is more likely when the Interplanetary Magnetic Field (B_z) points “south”



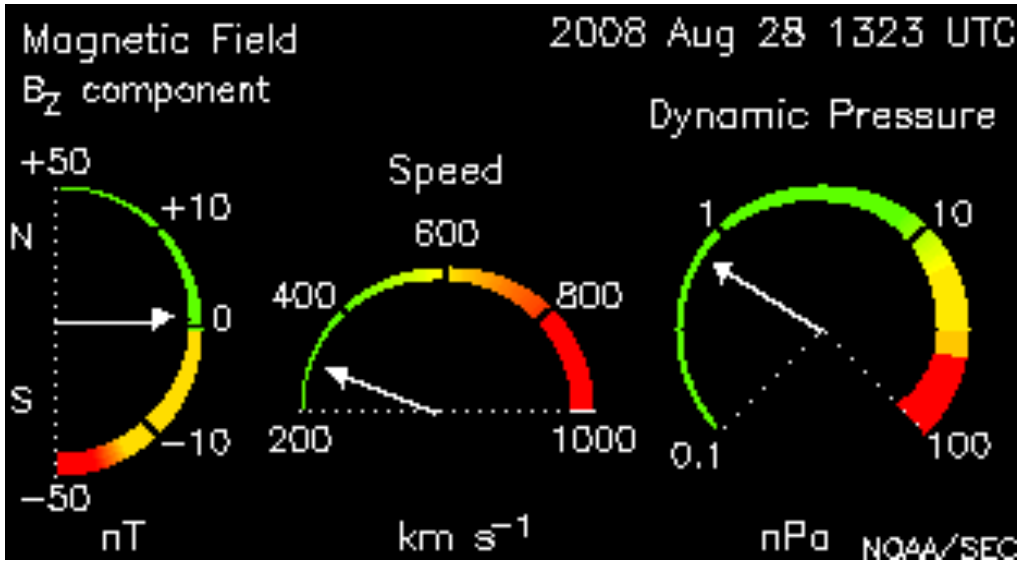
A brief run down on solar physics

A brief run down on solar physics

- To measure this see the gauge at

www.solarcycle24.com

- B_z going south and an increased solar wind speed (450km/s+) are generally bad news for HF



A brief run down on solar physics

- The K index shows the three -hourly effect of these particles impacting the geomagnetic field
- The A index is an average of this over 24 hours.

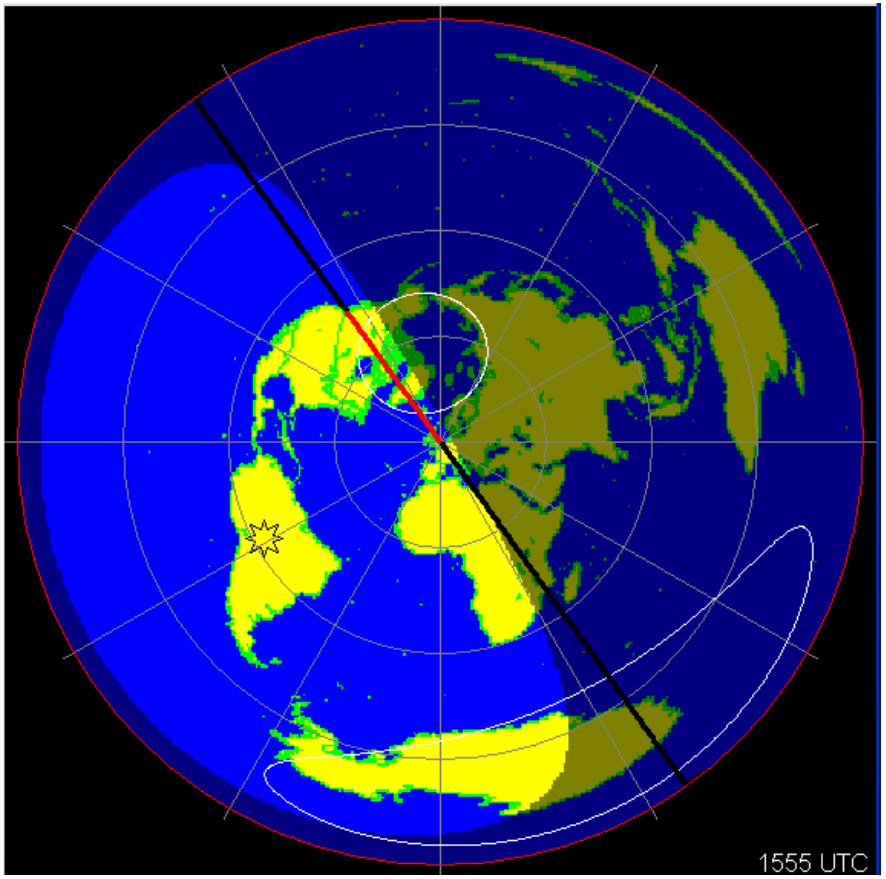
Aurora – K index is 5

A brief run down on solar physics

K-index	A	Boulder, CO observatory measurement (nT)	NOAA G-scale
0	0	0-5	G0
1	3	5-10	G0
2	7	10-20	G0
3	15	20-40	G0
4	27	40-70	G0
5	48	70-120	G1
6	80	120-200	G2
7	140	200-330	G3
8	240	330-500	G4
9	400	>500	G5

A brief run down on solar physics

- If your signals follow a polar path that cuts through the auroral zone(s) (eg G<>VE7 long or short path) and the K index is high you will have problems.

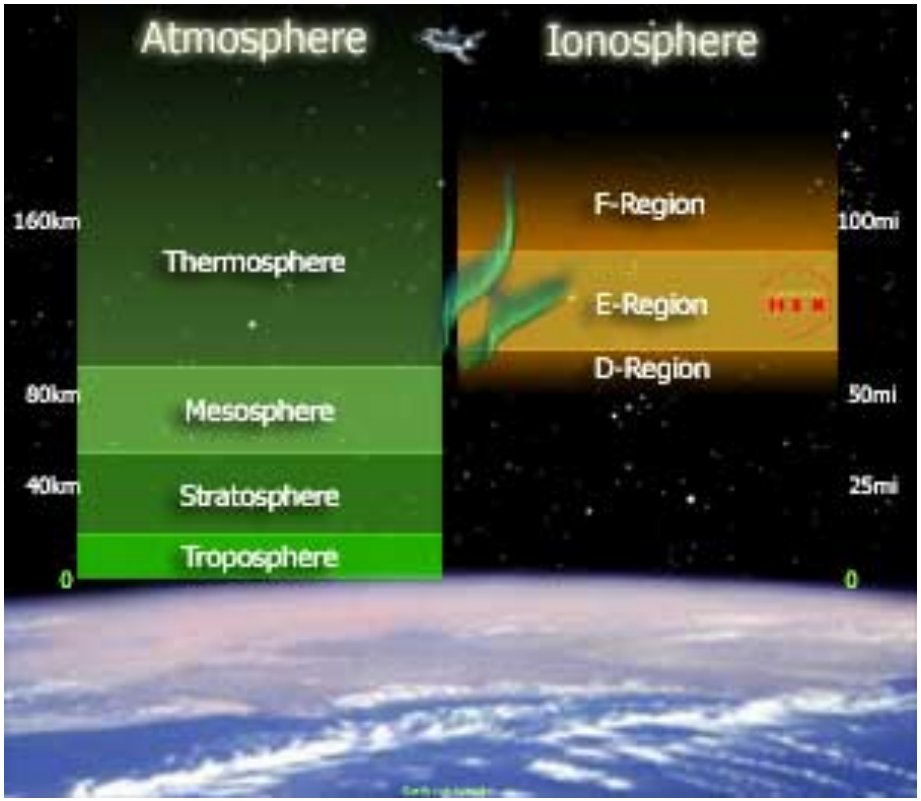


What about the ionosphere?

- **F-region**: The region used to propagate signals in the HF spectrum, notably 1.8MHz – 30MHz range

- **E-region**: 95-150km, contains mostly 0_2+ ions. The region used to propagate signals in the lower HF spectrum, notably 1.8MHz – 7MHz

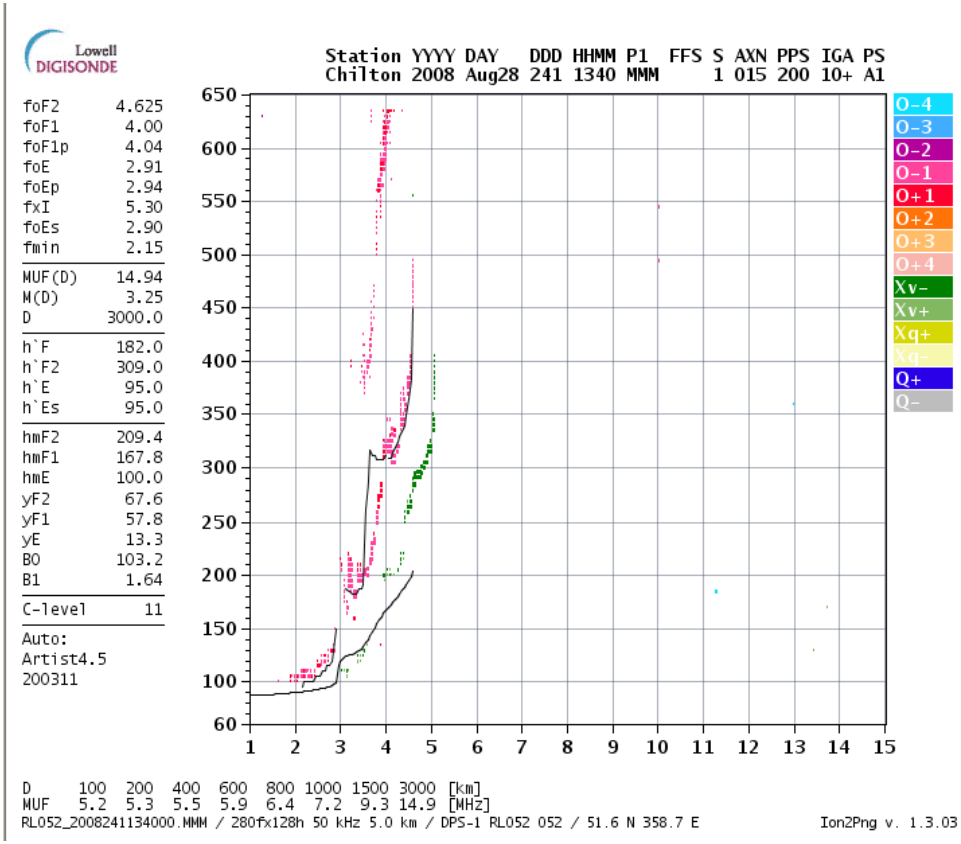
- **D-region**: 75-95 kilometres up, relatively weak ionisation due to its position at the bottom. For our purposes this is an **absorption** region, cutting down signals on 1.8 – 7MHz.



What does an ionogram tell us?

- The maximum usable frequency over a 100km (5.2MHz) - 3000km path (14.9 MHz)
- The f_0F_2 critical (straight up) frequency (4.625MHz)
- The f_0E critical frequency (2.91MHz)
- The f_0E_s Sporadic E critical frequency (2.9MHz)
- And much more

Source: http://www.ukssdc.ac.uk/



The D “Region”

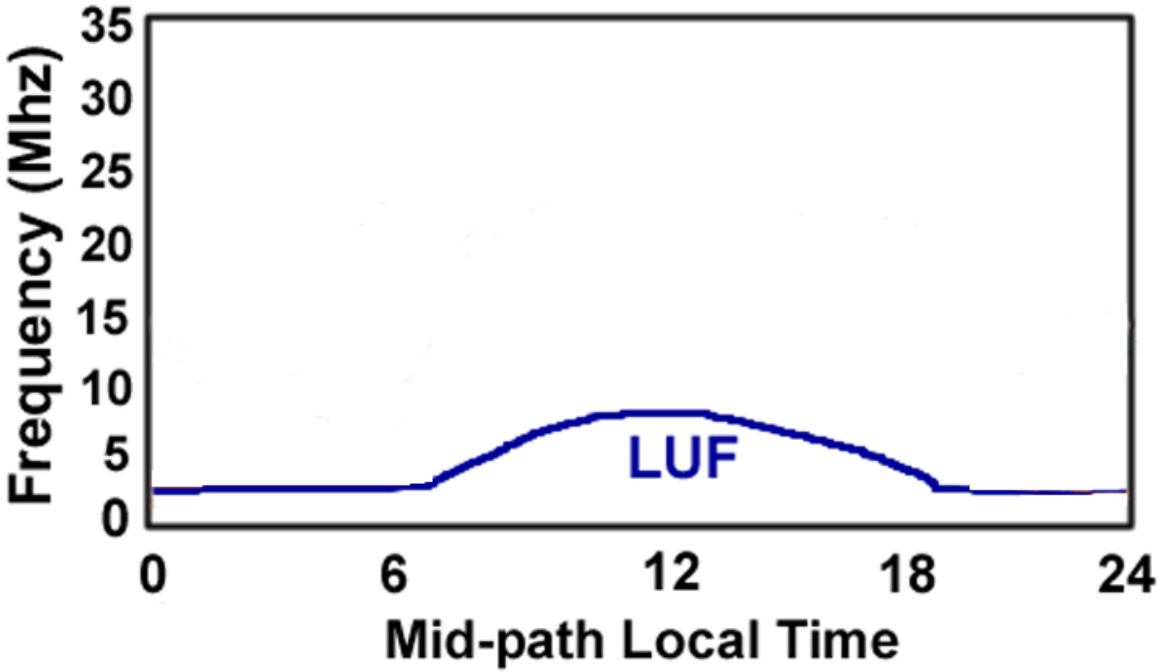
- Is at an average height of about 60-90km
- It is mainly responsible for absorbing/attenuating signals on 160-20m. It can reflect signals at VLF
- This is why we don’t hear “much” skip on the LF bands during daylight, especially in summer
- The actual level of absorption is dependent upon the frequency, time of day/year and solar /geomagnetic levels

D Layer Absorption:

Absorption (db)= $(10 * log[\text{flux } (W\, m^{-2})] + 65)^{2}/f^{2}$

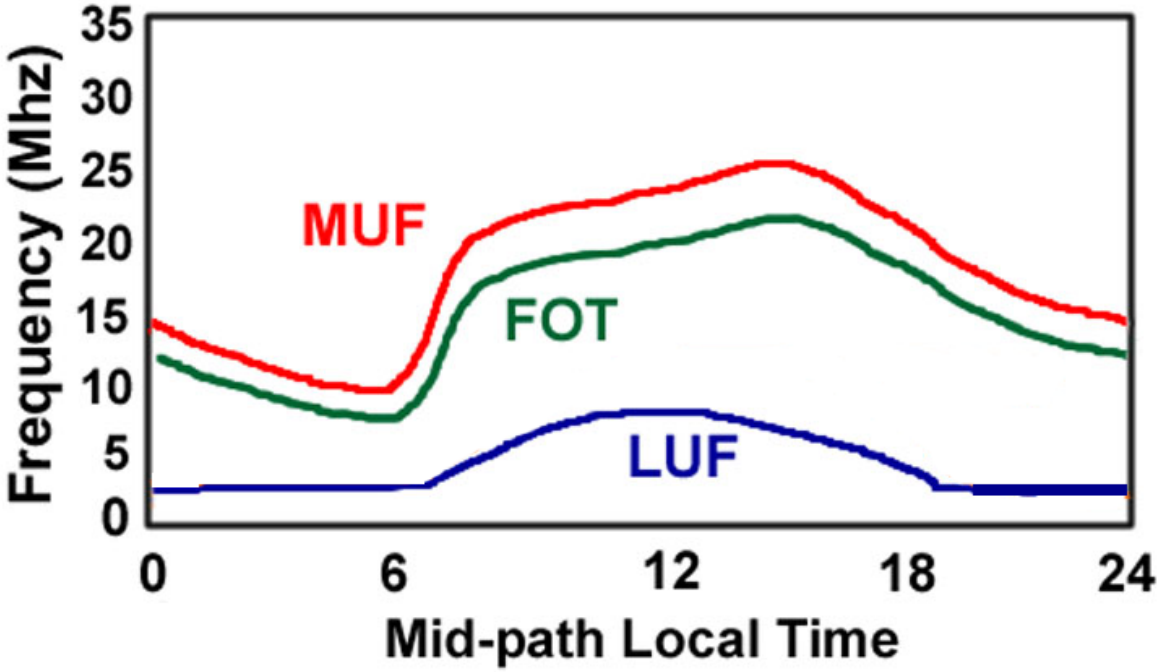
- That is, the lower the frequency, the more the absorption

Putting it all together:



The lowest usable frequency increases at sunrise

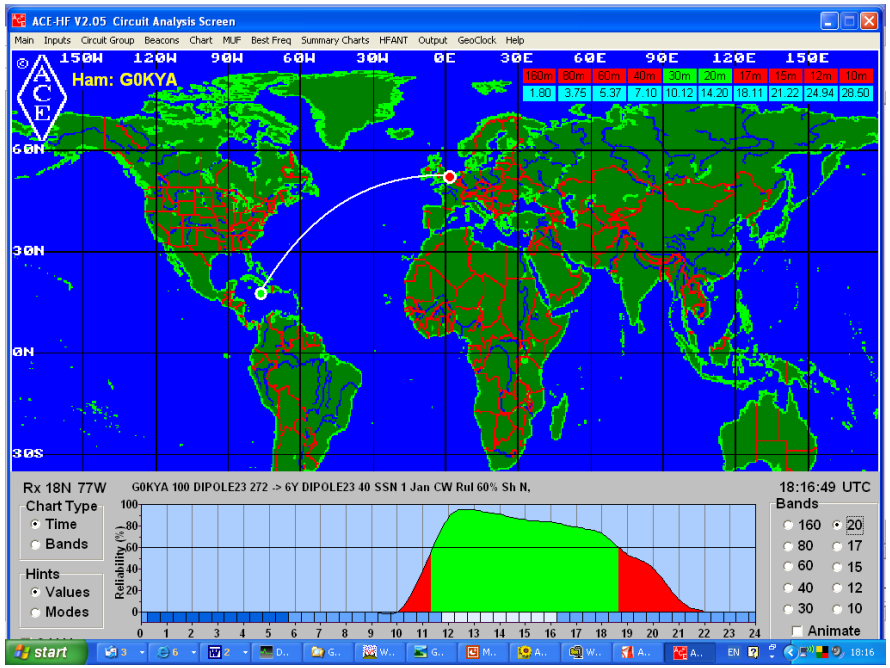
Putting it all together:

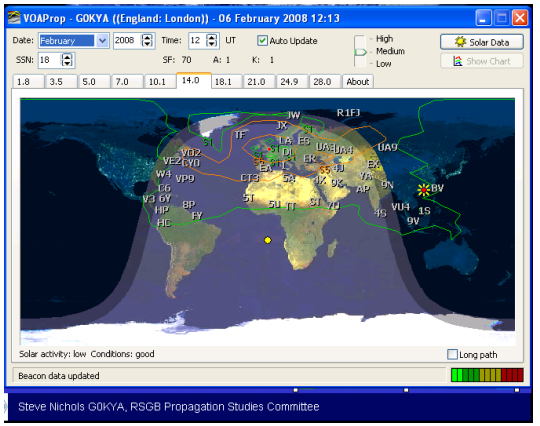


The MUF also increases – the FOT gives the highest "probability" for the contact you want to make.

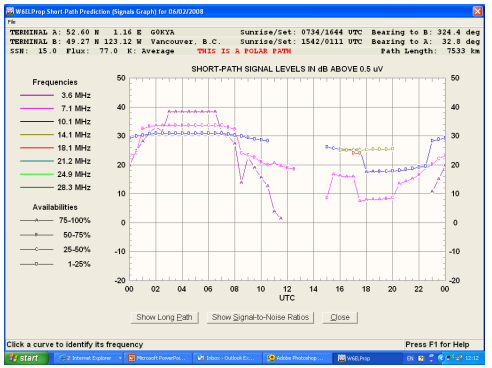
Using propagation prediction programs

ACE-HF http://home.att.net/~acehf/



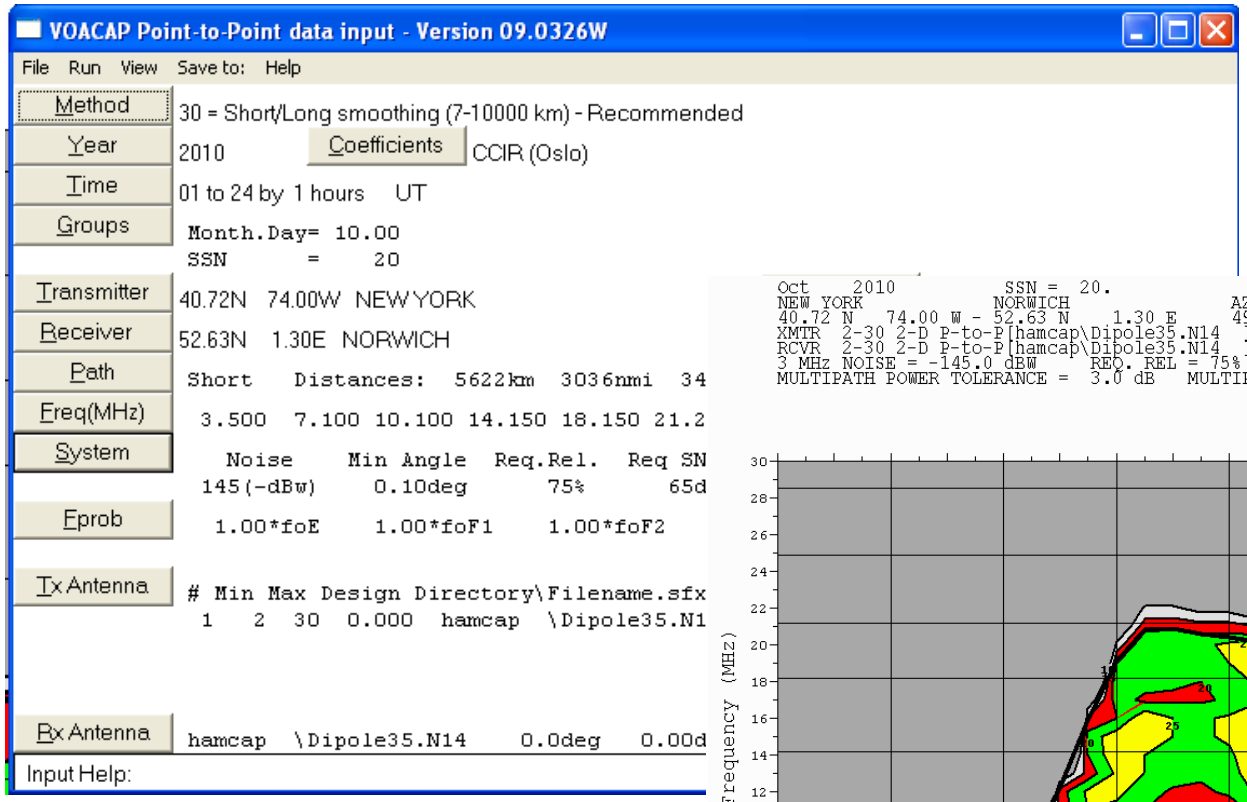


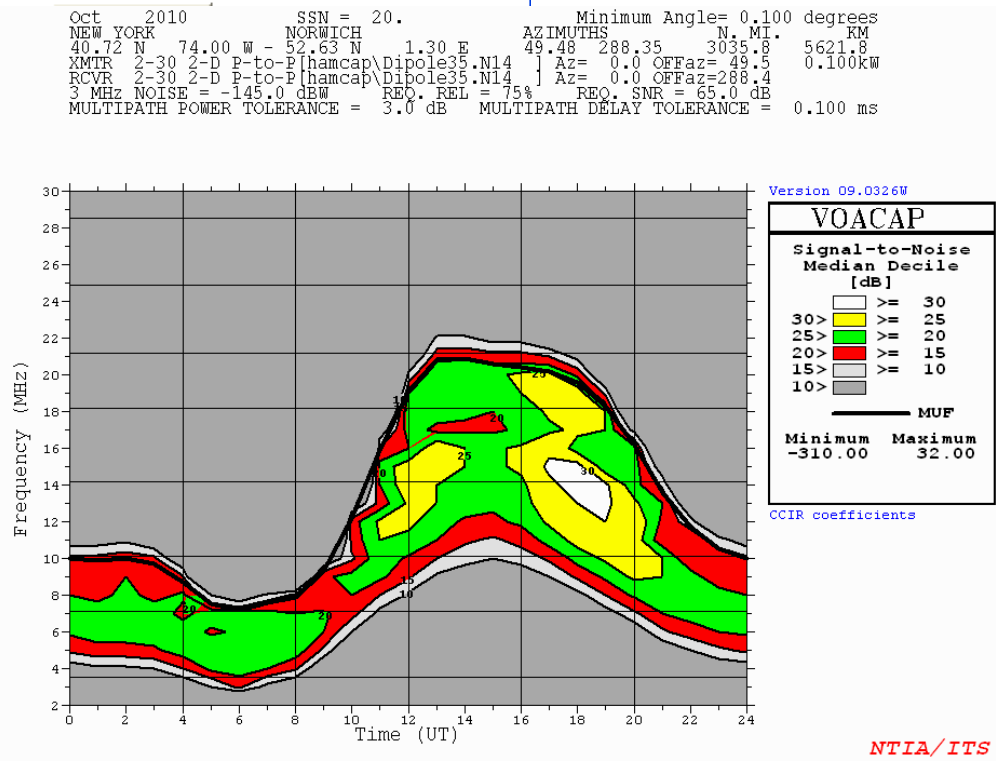
VOAProp
www.g4ilo.com/voaprop.html



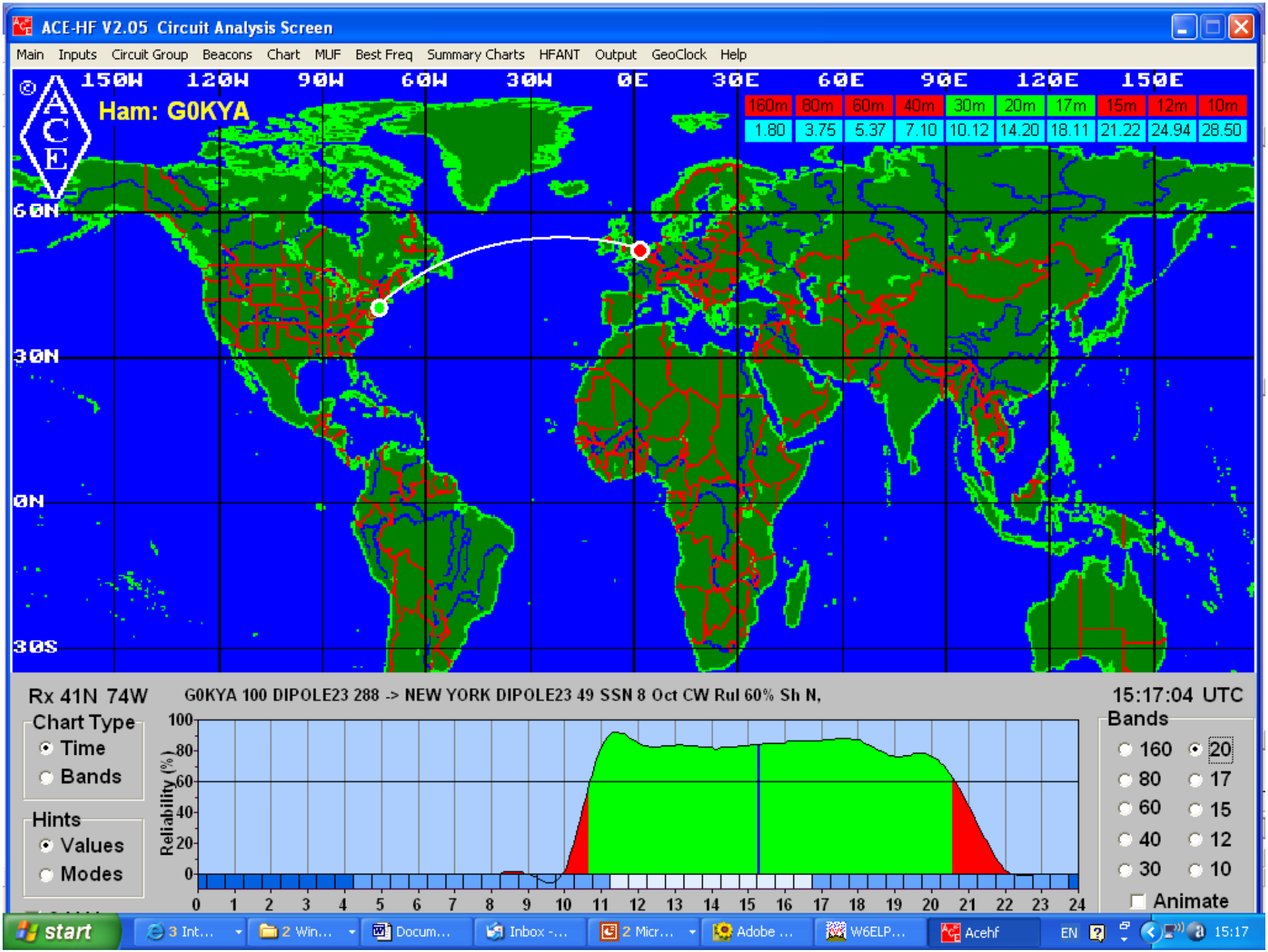
W6ELProp
www.qsl.net/w6elprop/

VOACap

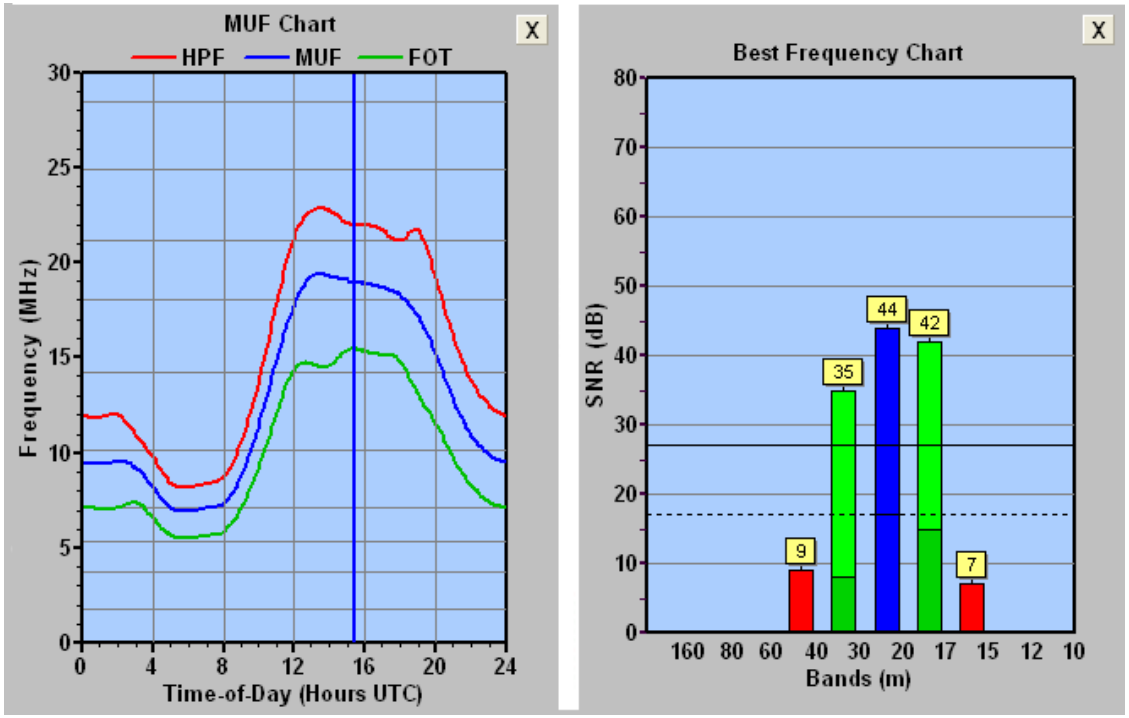




Excellent – but
not user friendly
Doesn't do well for 80m or Top band predictions


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 8 Oct CW Rul 60% Sh N,
15:17:04 UTC
Chart Type
Time
Bands
Hints
Values
Modes
Reliability (%)
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Bands
160 20
80 17
60 15
40 12
30 10
Animate
start
3 Int...
2 Win...
Docum...
Inbox -...
2 Micr...
Adobe ...
W6ELP...
Acehf
EN
15:17

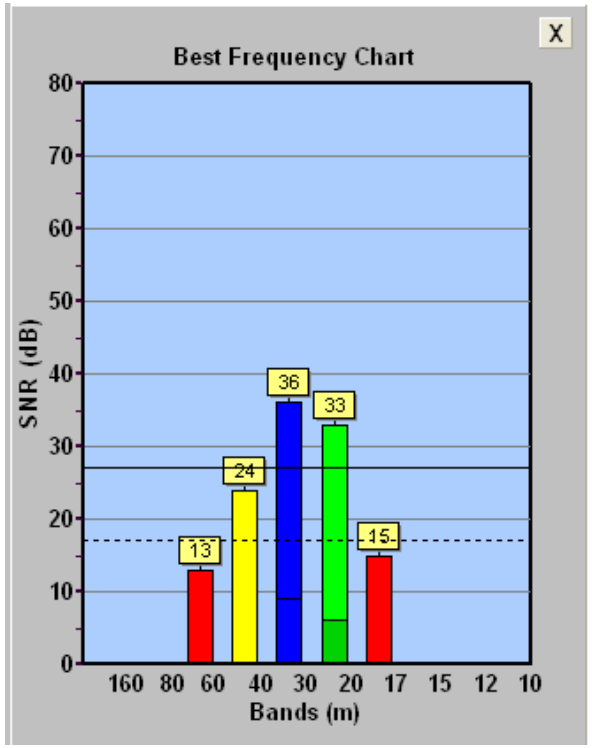
Using propagation prediction programs

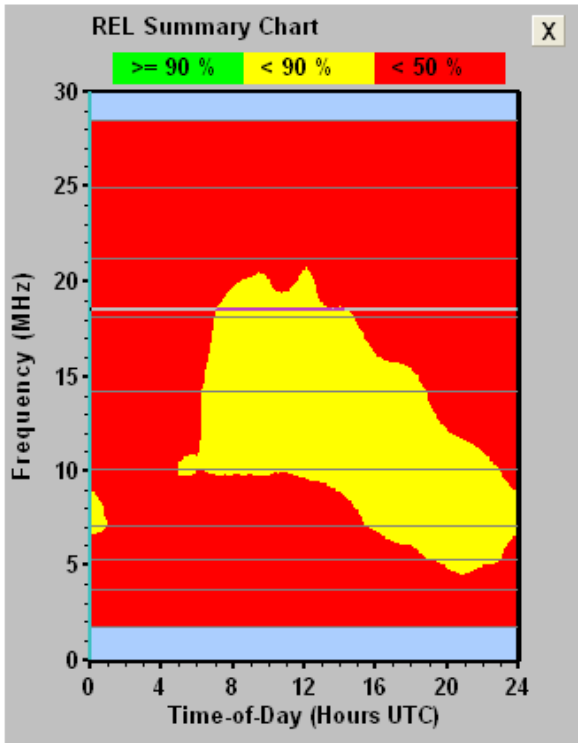


- **Path from G to east coast USA, October 1530UTC - ACE-HF**
- Frequency of Optimum Transmission (FOT), the Maximum Usable Frequency (MUF) and the Highest Probable Frequency (HPF).

Using propagation prediction programs

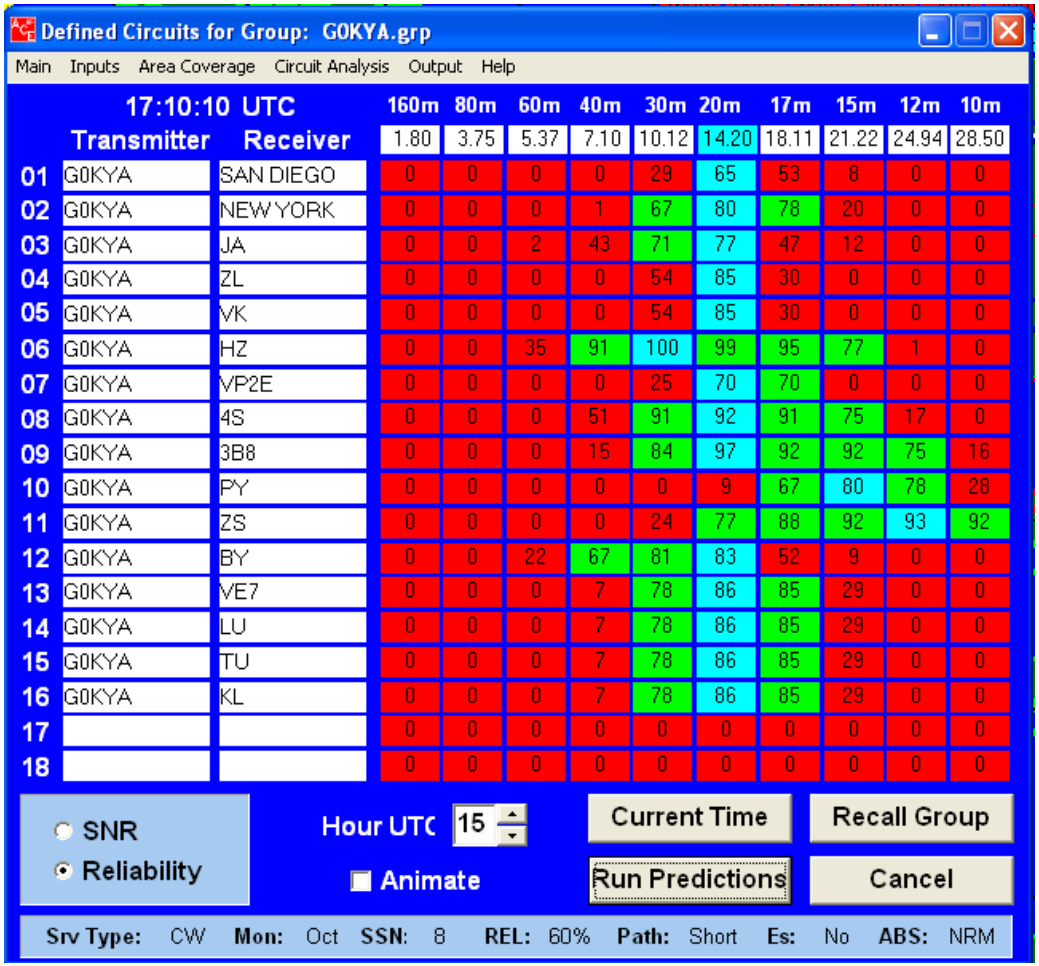
- Best frequency at 13.30hrs and 24 hr reliability chart for G to JA path, October 2008 – note LUF/MUF falling off as night falls





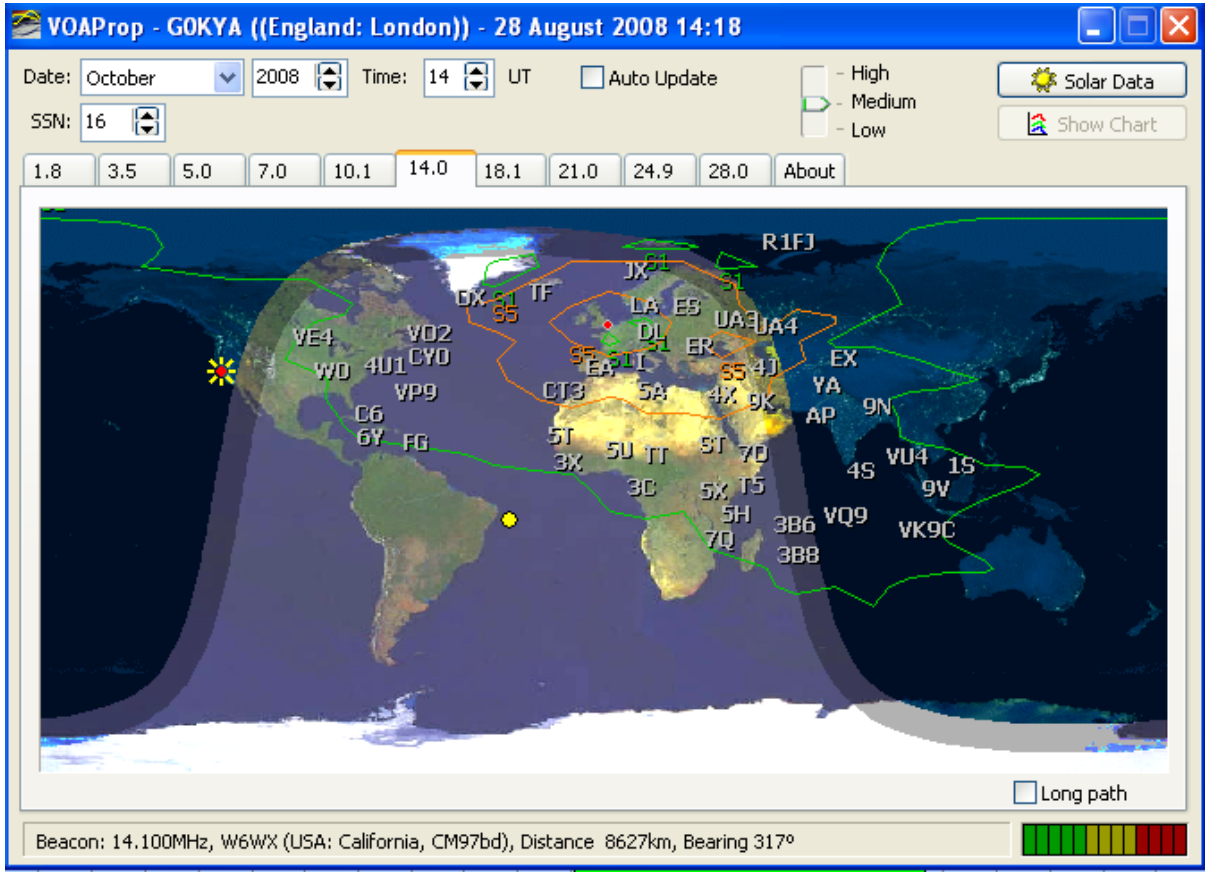
Using propagation prediction programs

- Reliability for G to rest of world, 1500UTC October, sunspot number 8, short path.

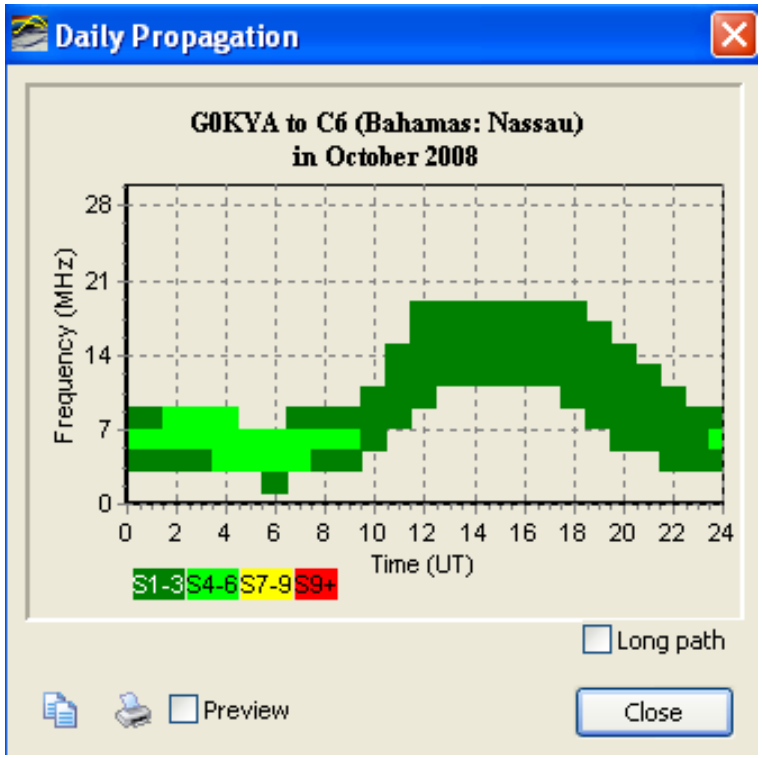


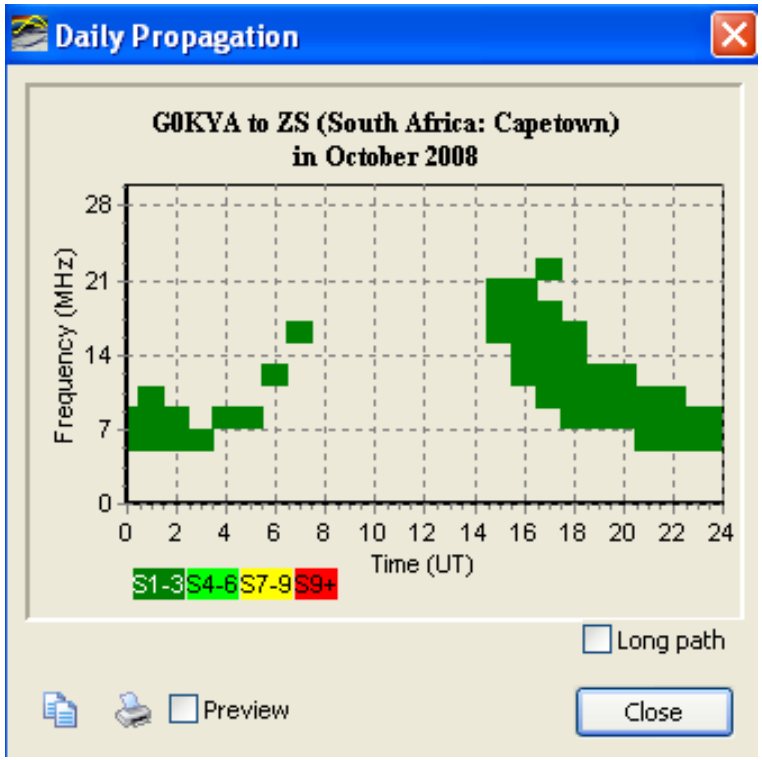
Use propagation prediction programs

VOAProp



Use propagation prediction programs





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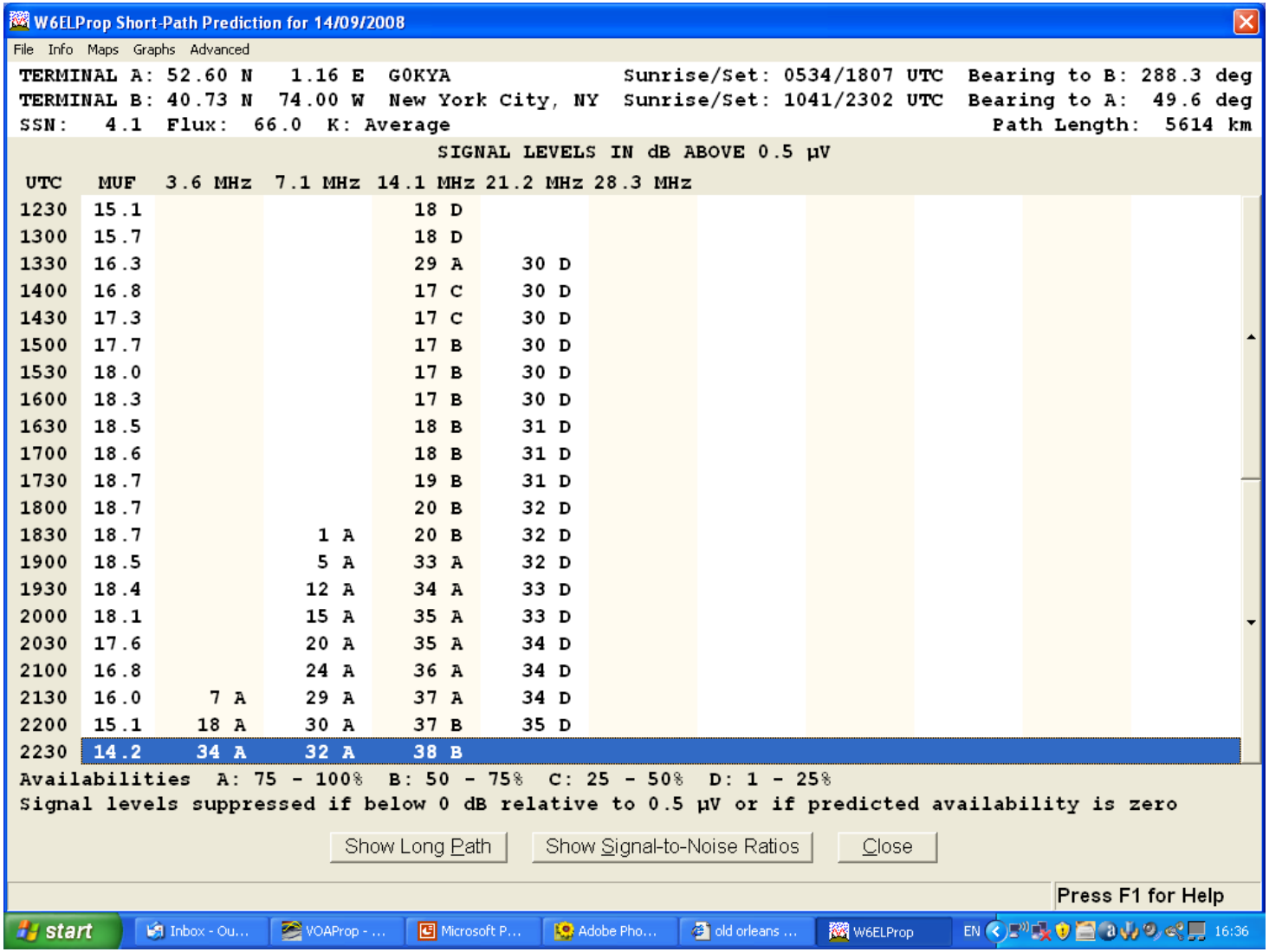
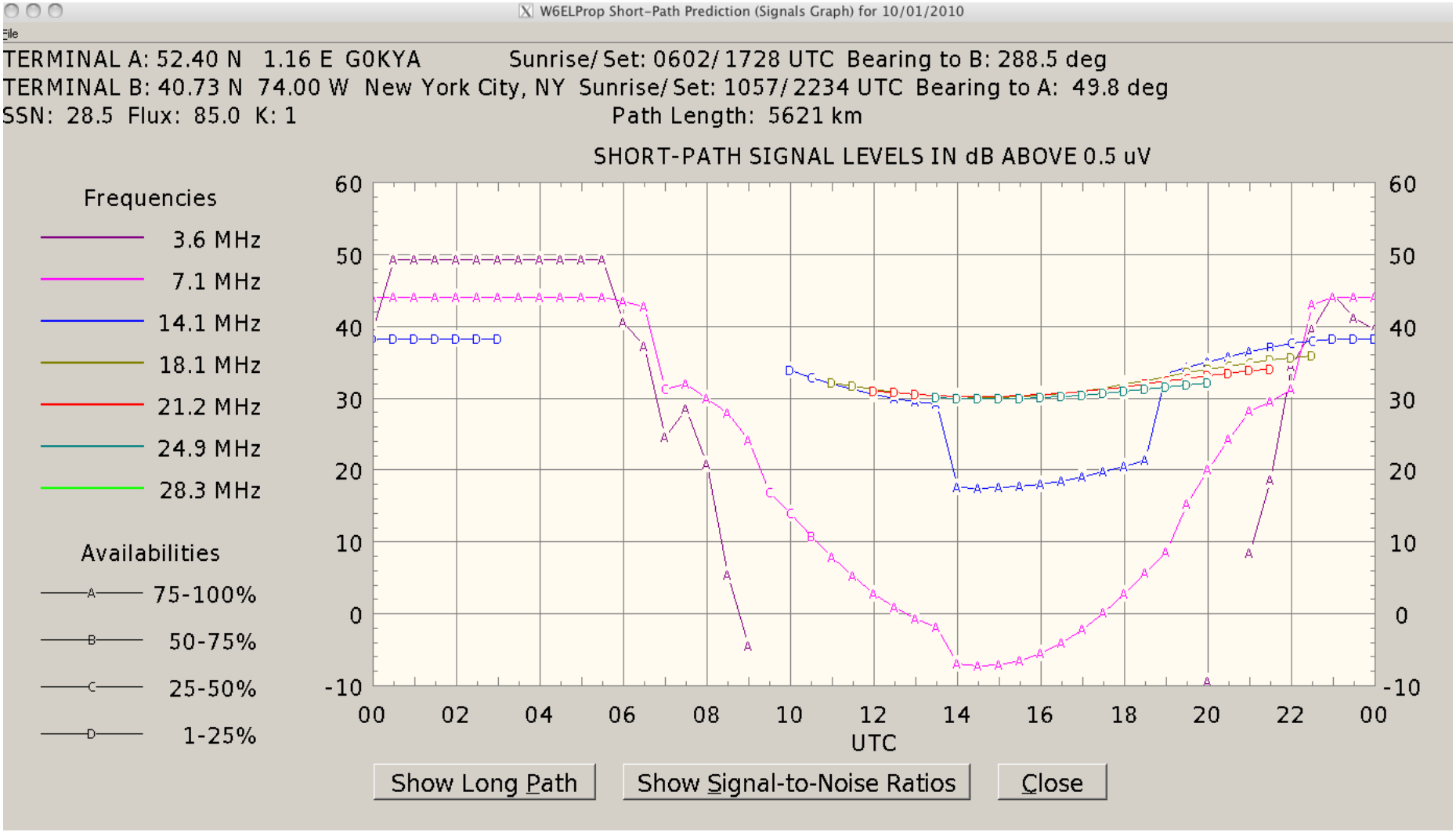
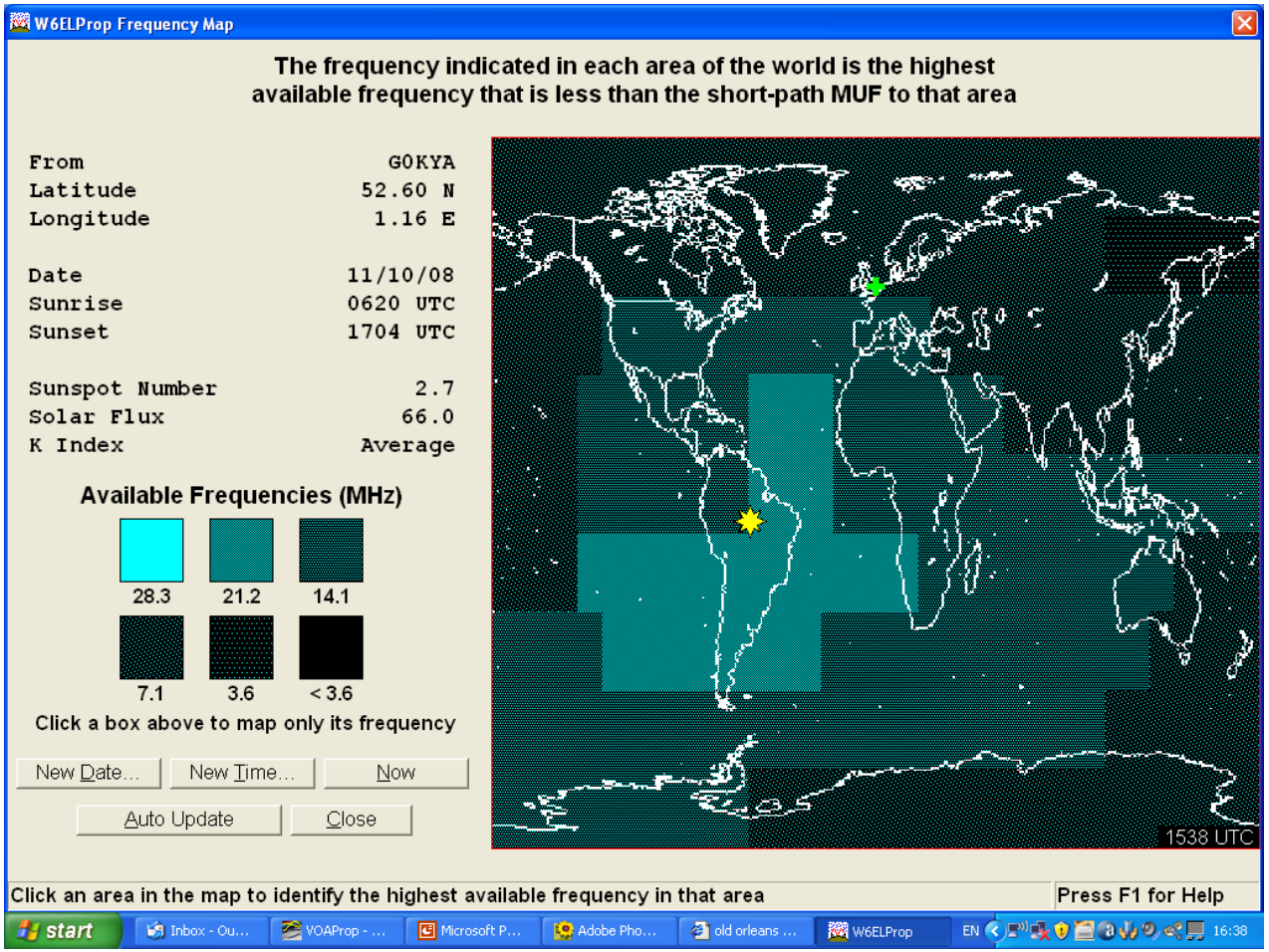


W6ELProp – can give you a table view …



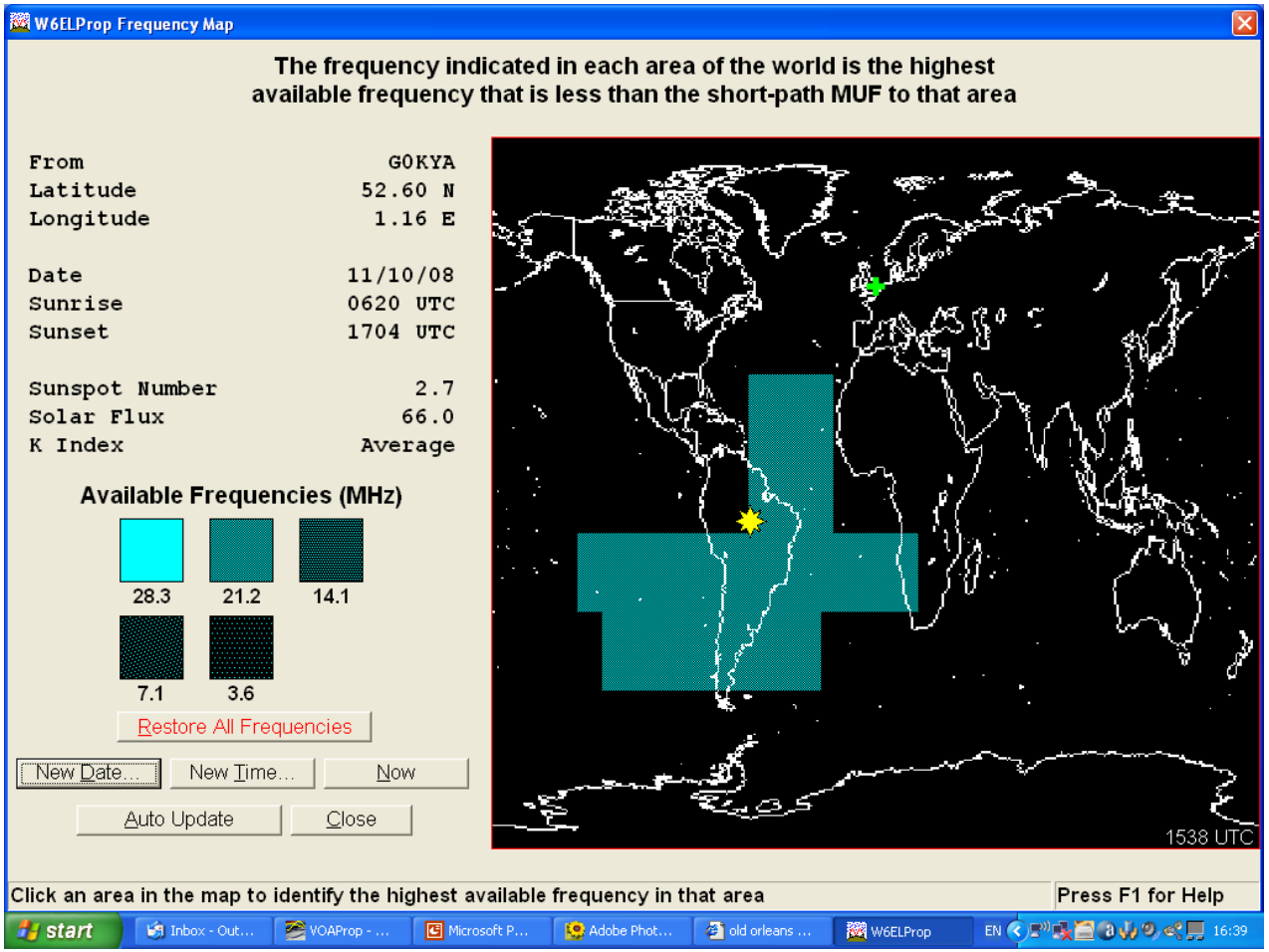
… or a graphical view

Using W6ELProp (all bands)

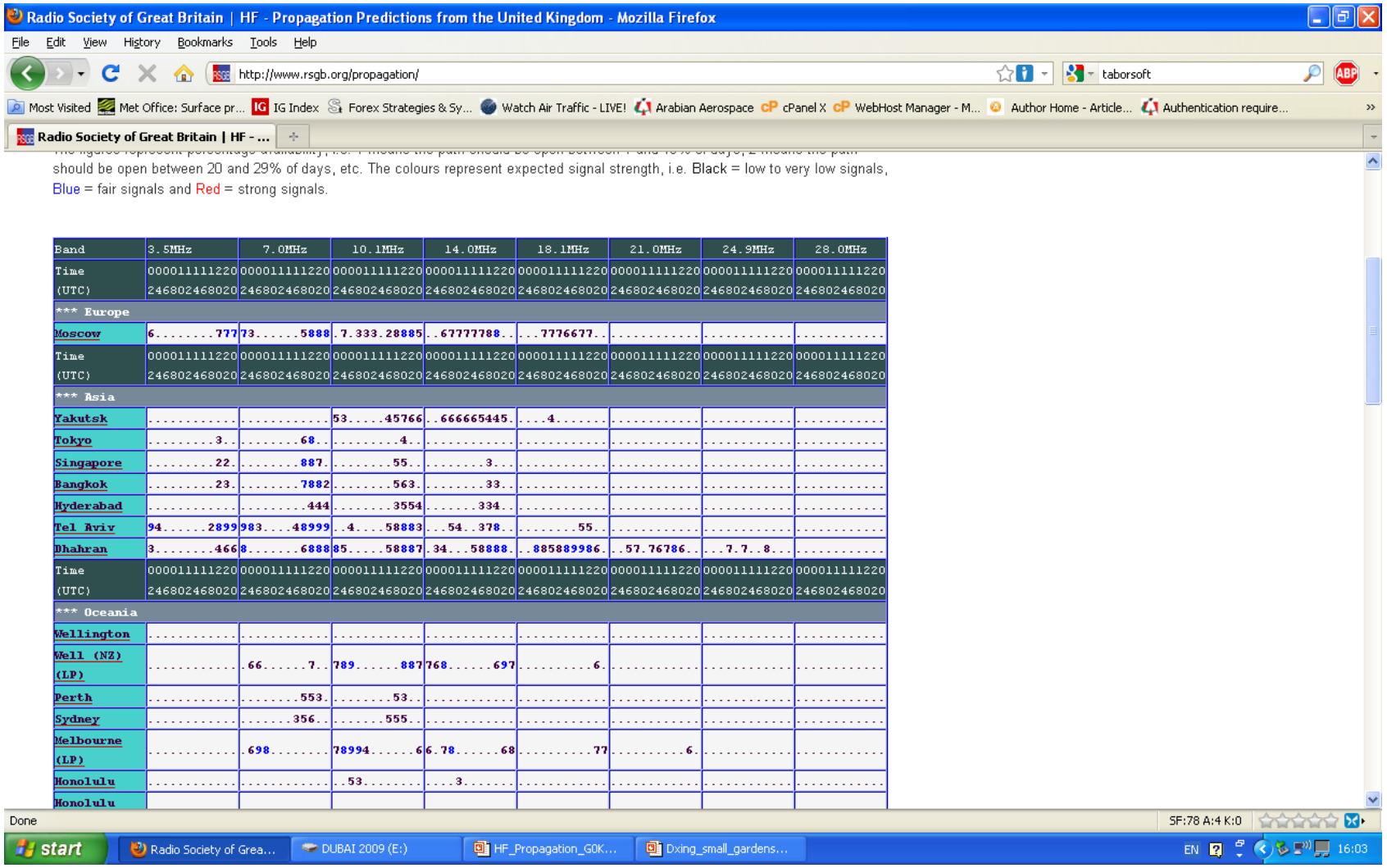


Its map views are a little clunky

Using W6ELProp (15m only)



Using RSGB tables



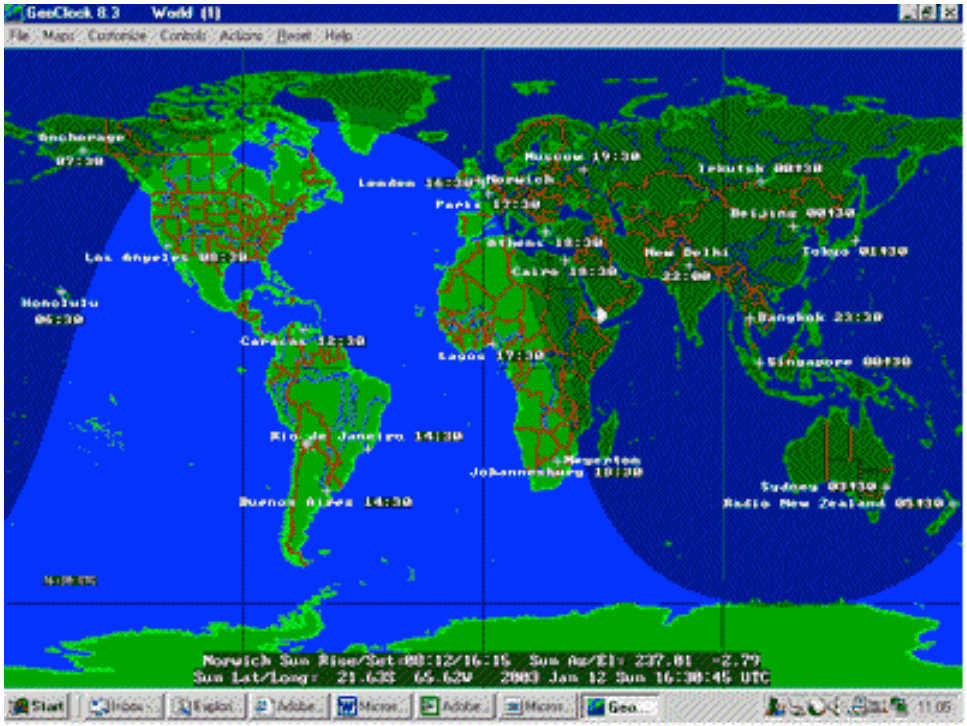
Band	3.5MHz	7.0MHz	10.1MHz	14.0MHz	18.1MHz	21.0MHz	24.9MHz	28.0MHz
Time (UTC)	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020
*** Europe								
Moscow	6.....777	73.....5888	.7.333.28885	..67777788..	...7776677..			
Time (UTC)	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020
*** Asia								
Yakutsk			53.....45766	..666665445.	....4.....			
Tokyo	.....3..	.....68..	.....4..					
Singapore	.....22.	.....887.	.....55..	.....3...				
Bangkok	.....23.	7882	.....563.	.....33..				
Hyderabad		444	3554	.....334..				
Tel Aviv	94.....2899	983....48999	..4....58883	...54..378..	.....55..			
Dhahran	3.....466	8.....6888	85.....58887	.34...58888.	..885889986.	..57.76786..	...7.7..8...	
Time (UTC)	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020	000011111220 246802468020
*** Oceania								
Wellington								
Well (NZ) (LP)		66.....7..	789.....887	768.....697	.....6.			
Perth		.....553.	.....53..					
Sydney		.....356..	.....555..					
Melbourne (LP)		698.....	78994.....6	6.78.....68	77	.....6.		
Honolulu			..53.....	....3.....				
Honolulu								

You can get these from RadCom or the RSGB web site

What is “Greyline” propagation?

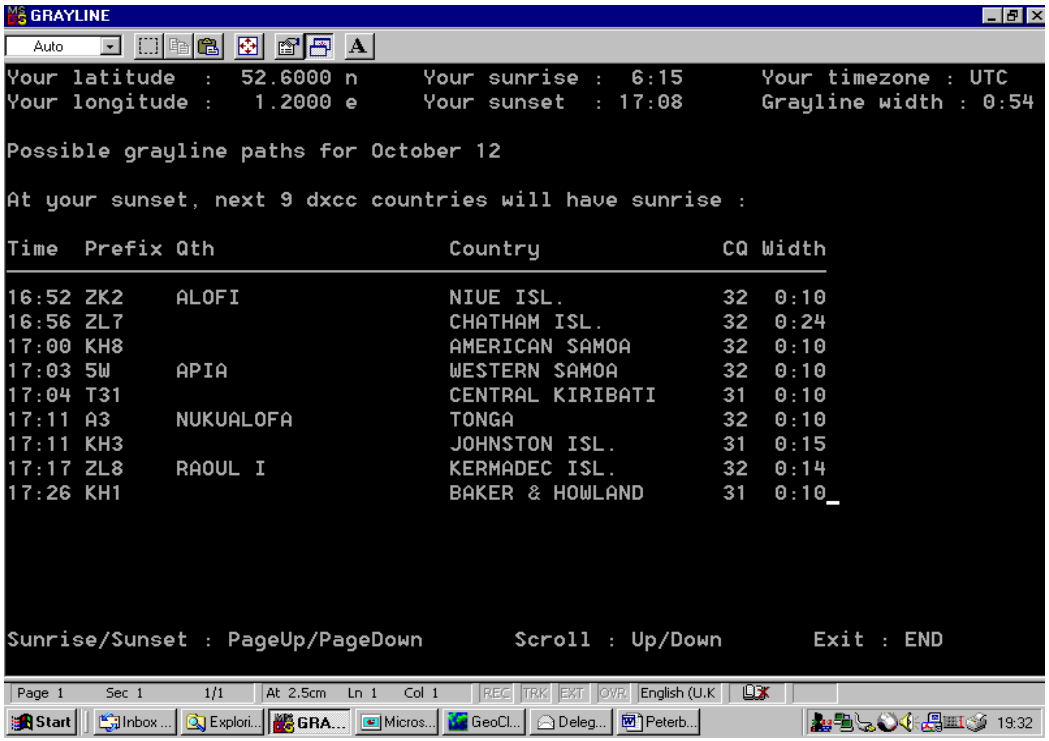
- The phrase was first coined in 1975
- It describes the propagation of radio waves **along** the terminator separating night and day (sunrise/sunset) - this is the “Greyline” path (or “Grayline” in USA)
- Generally, “Greyline” is commonly used to describe ANY propagation path occurring at or around sunrise or sunset
- These should really be called sunrise or sunset “enhancements”

Greyline conditions for a G sunset over a full year



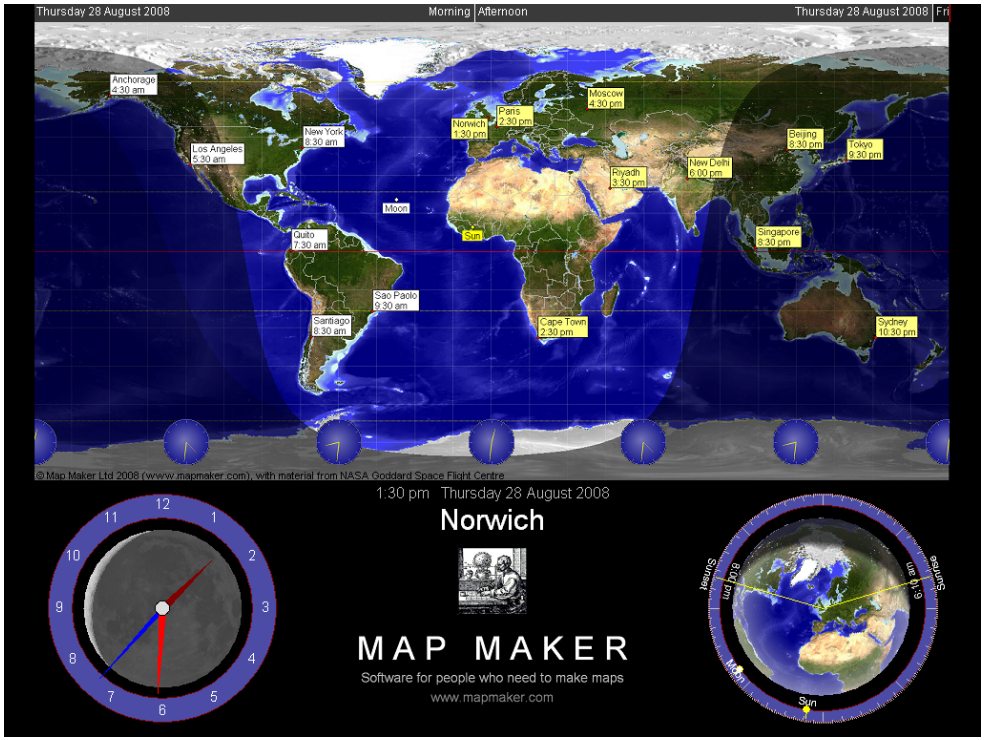
How do we predict greyline openings?

- With software – this is by PA3CQR



How do we predict greyline openings?

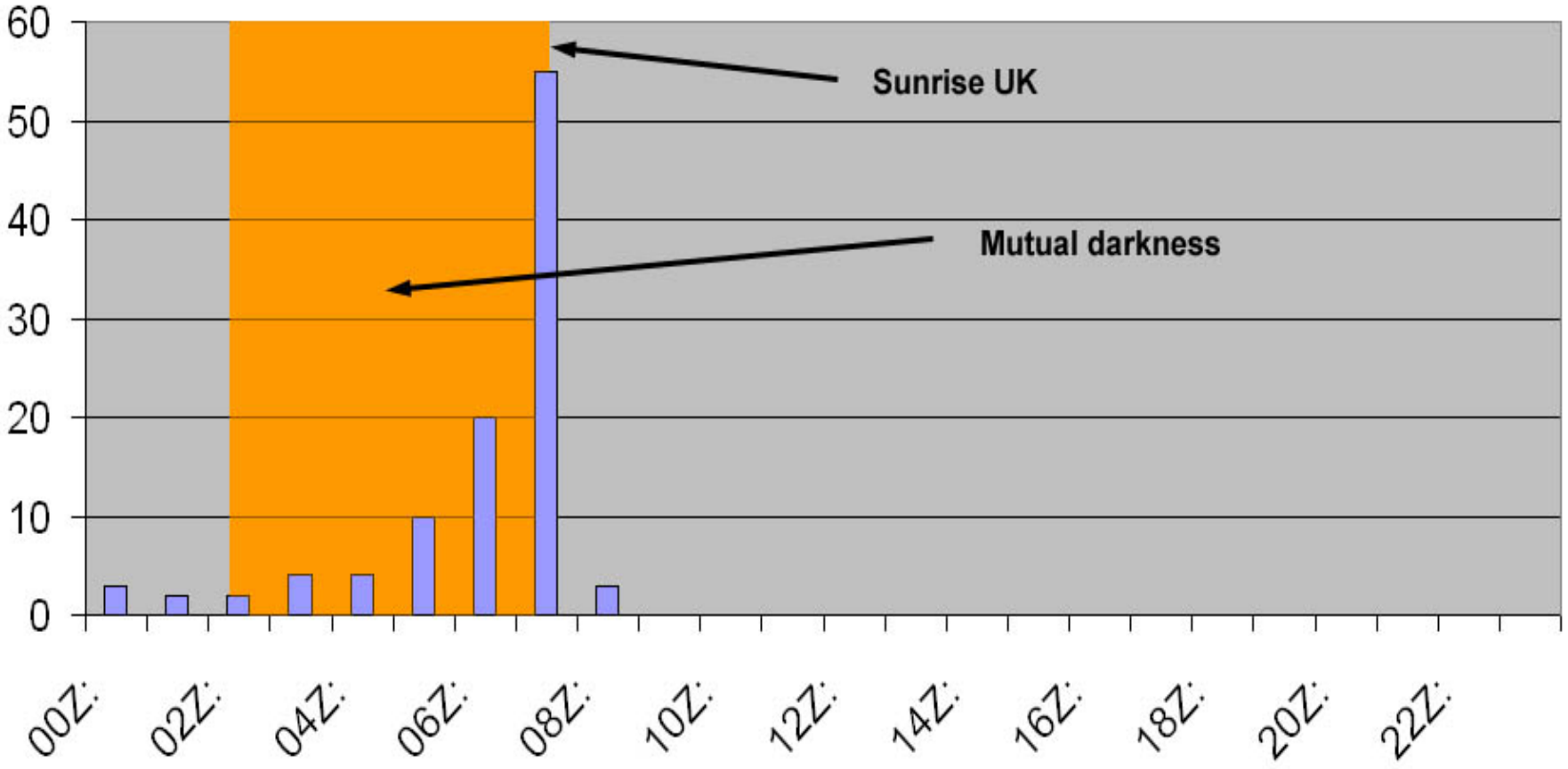
- With software – this is by MapMaker



Is there a twilight "sweet spot"?

- In "*Contesting in Africa – Multi-Multi on the Equator*" Robert Ferguson, GM3YTS outlines several Top Band QSOs that took place 25-30 minutes before/after the other stations' sunrise/sunset.
- In *"Low band Dxing"* ON4UN says that signals on Top Band can peak at sunrise or sunset, or in the night – very unpredictable!
- On 80 and 40 meters, signals always peak **AFTER SUNRISE** to the west and **BEFORE** sunset to the east (N4KG)

Peter 1st Island (3Y0X)
80m contacts v sunrise



Peter 1st Island (3Y0X)
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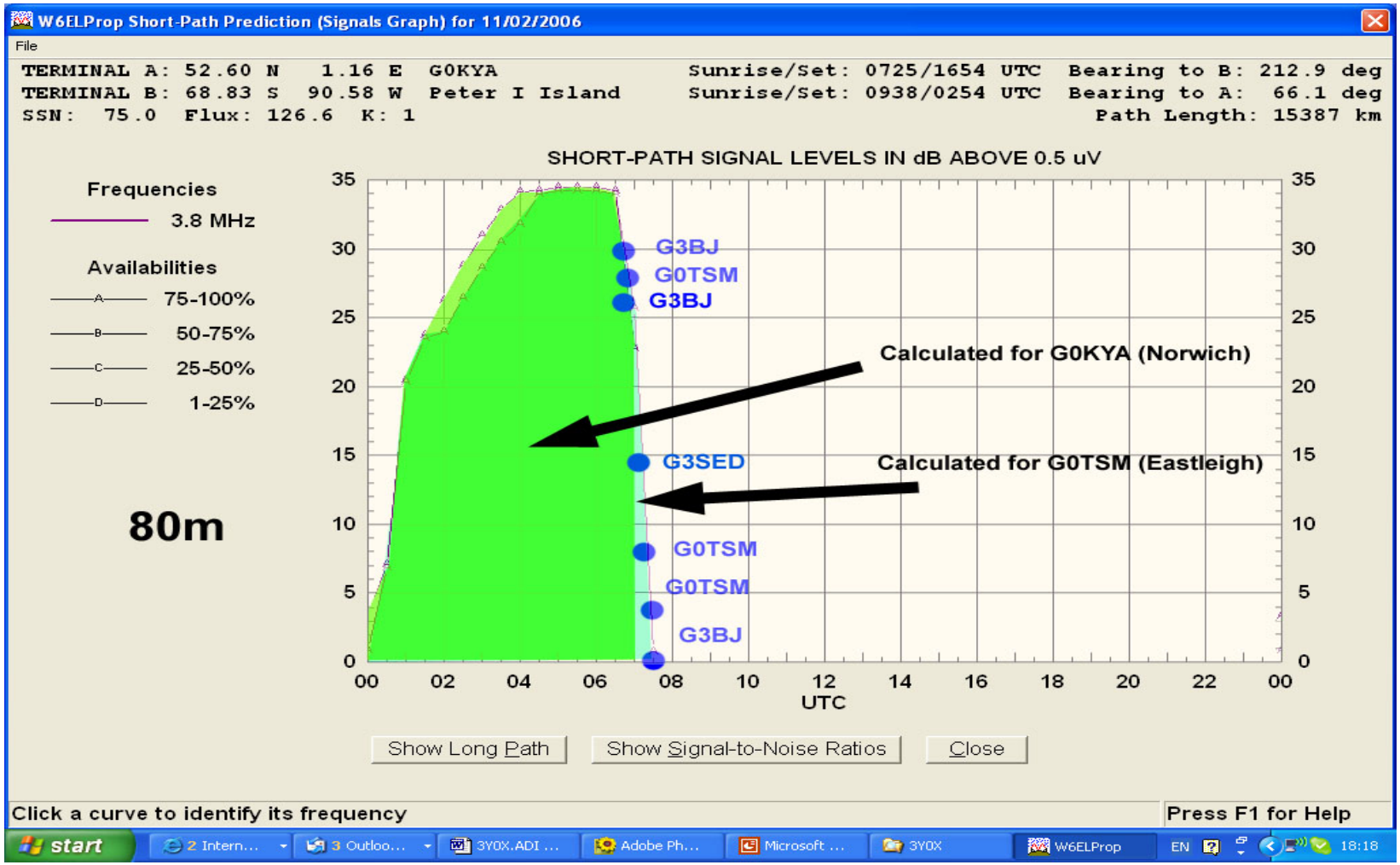

Putting it all together

- Higher solar flux levels are generally good for HF
- High K and A indices are generally bad – result in absorption and breakdown of the F region.
- Chilton ionogram/ Solar Flux /K index/ Solar wind speed and Bz will give you a real-time indication of what bands you should concentrate on.
- Spring/Autumn/Winter are better than Summer as the ionosphere is cooler, denser and MUF is higher during the day. Ionic composition is different in Winter too. But night time MUFs are higher in summer.
- The opposite is true in the southern hemisphere
- Spring/Autumn good for trans-equatorial contacts
- As the sun gets higher D layer absorption grows, but the MUF rises, so follow the MUF up during the day and down at night.