

HF Propagation and Software

RSGB Hamfest, Newark 2010

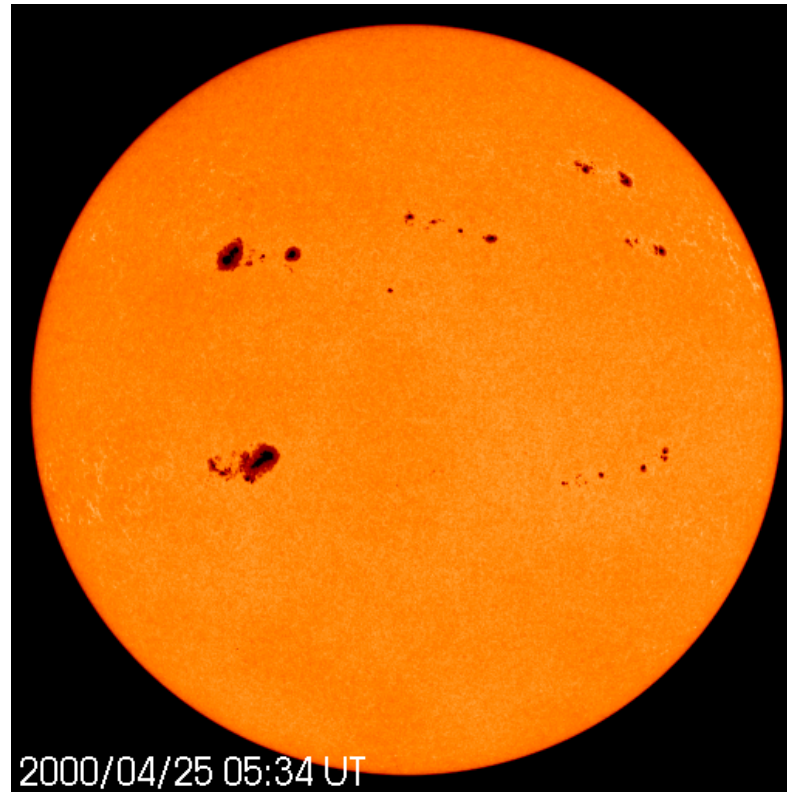
Steve Nichols G0KYA
www.qsl.net/g0kya

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

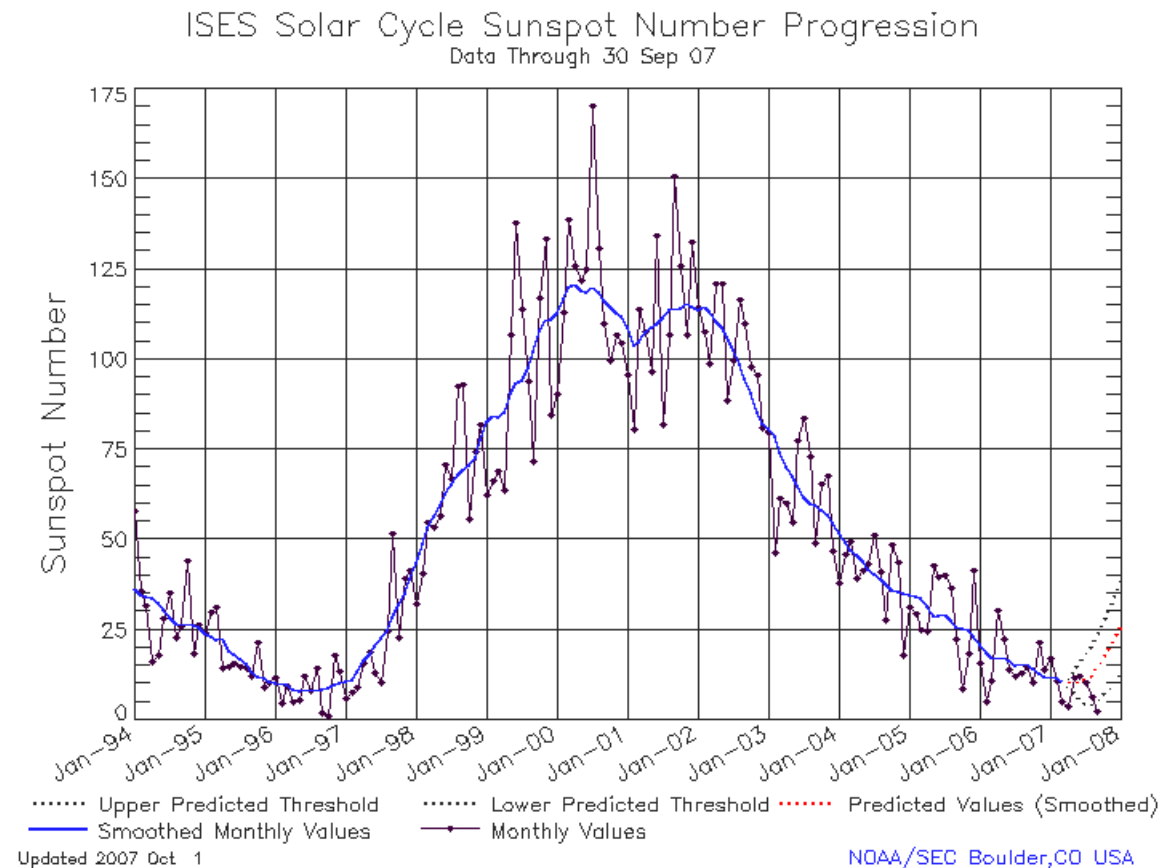


A brief run down on solar physics

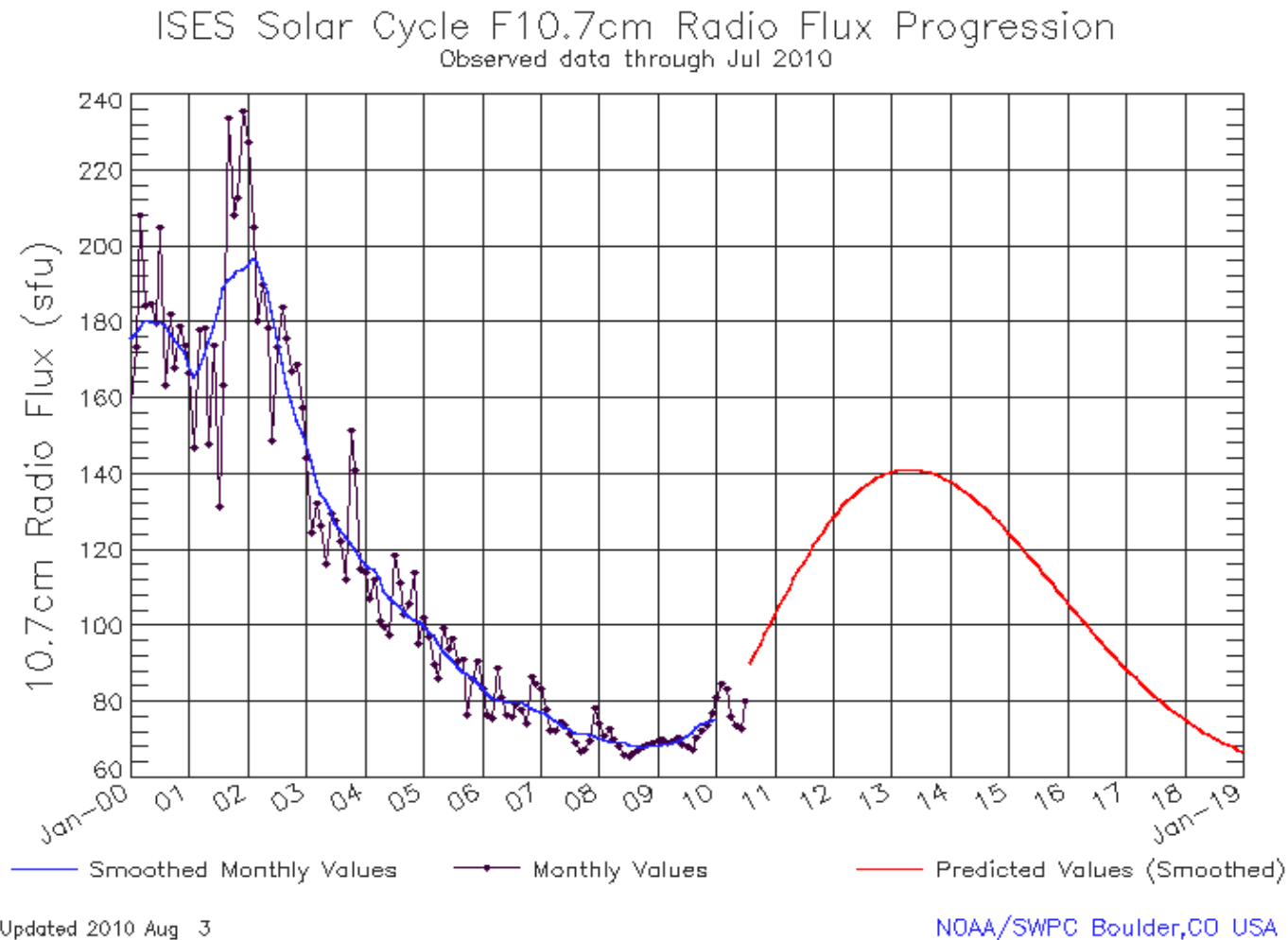
- The solar flux can be as low as 65 (2008) or as high as 274 (2001)

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.

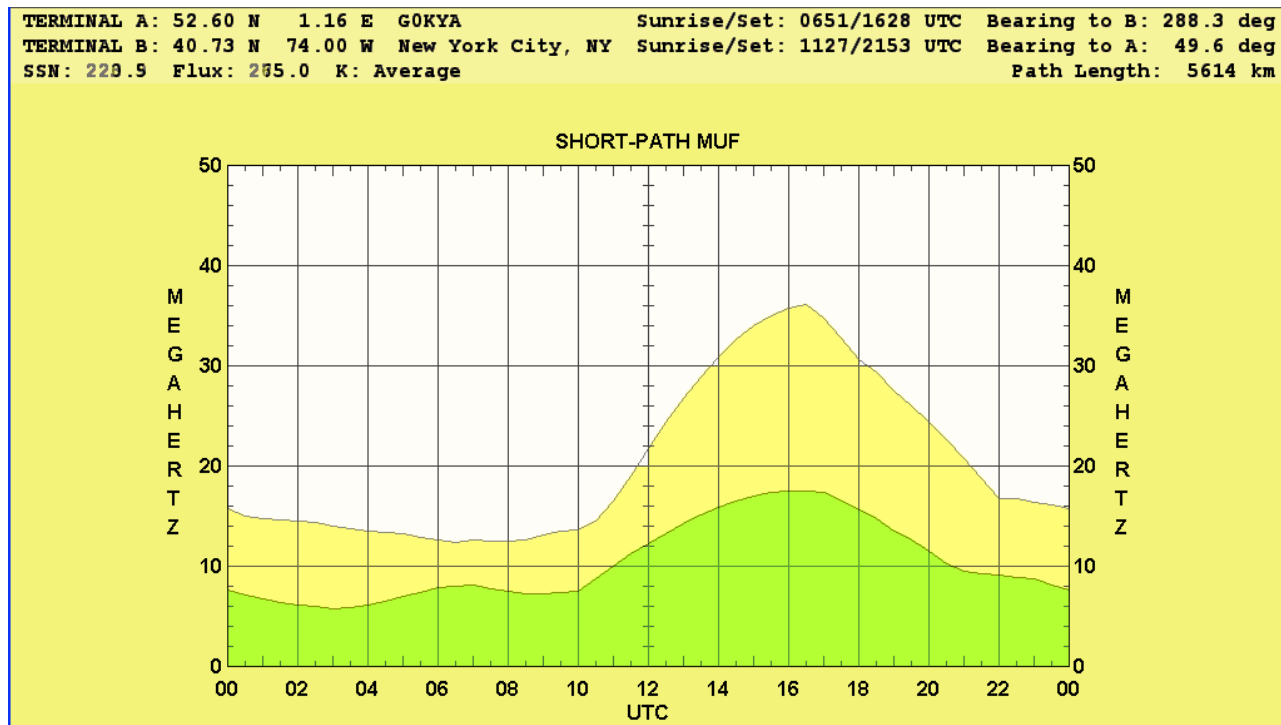


A brief run down on solar physics



Where are we we in the cycle?

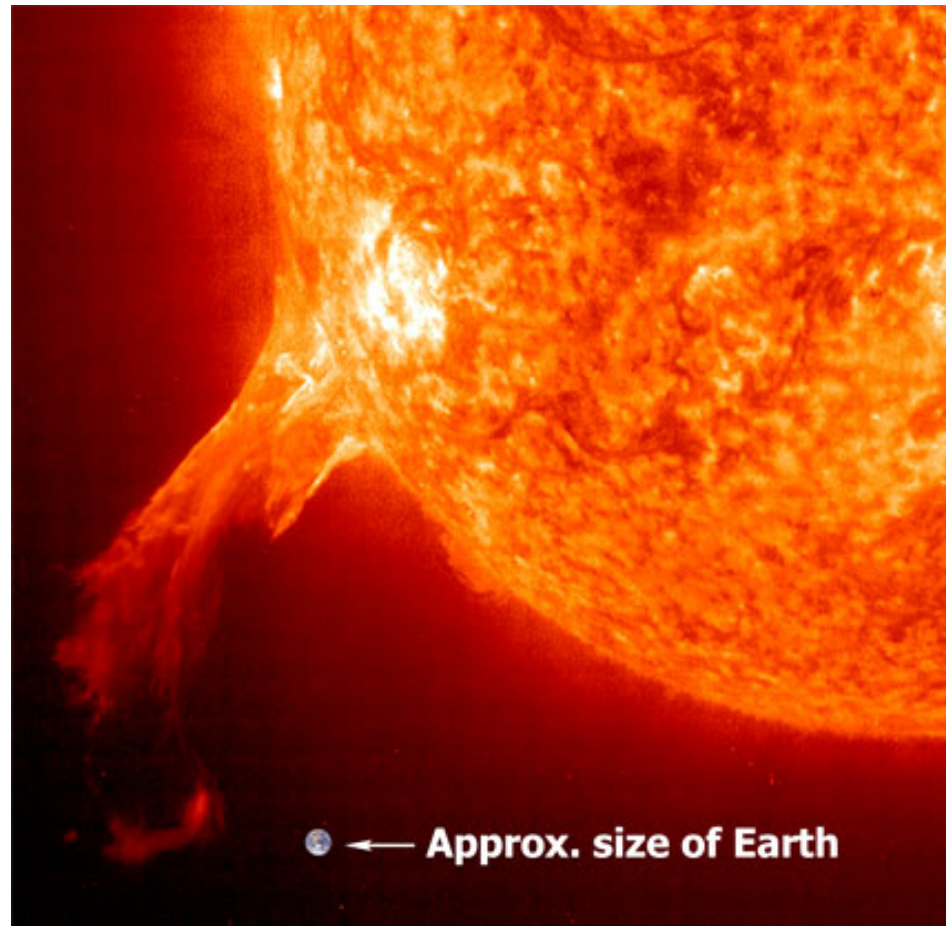
A brief run down on solar physics



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

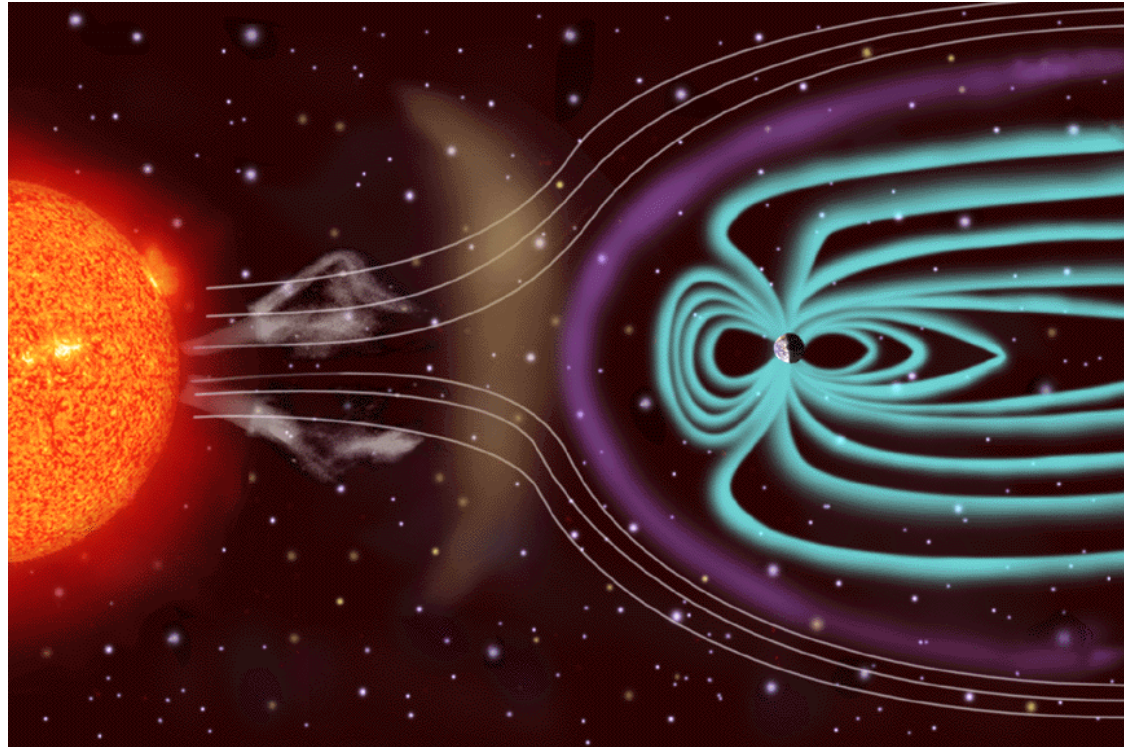
A brief run down on solar physics

- 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

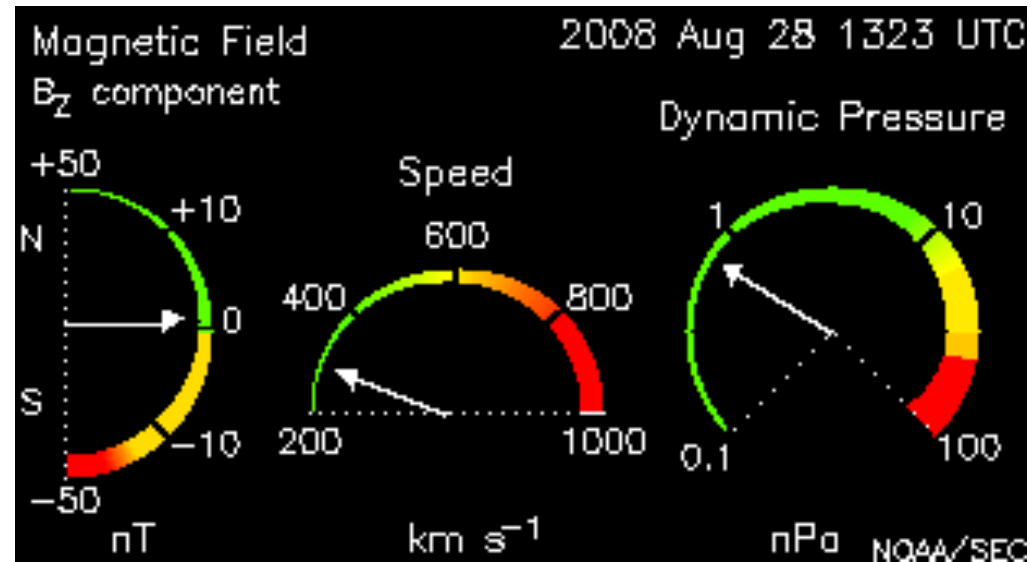


A brief run down on solar physics

- 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.



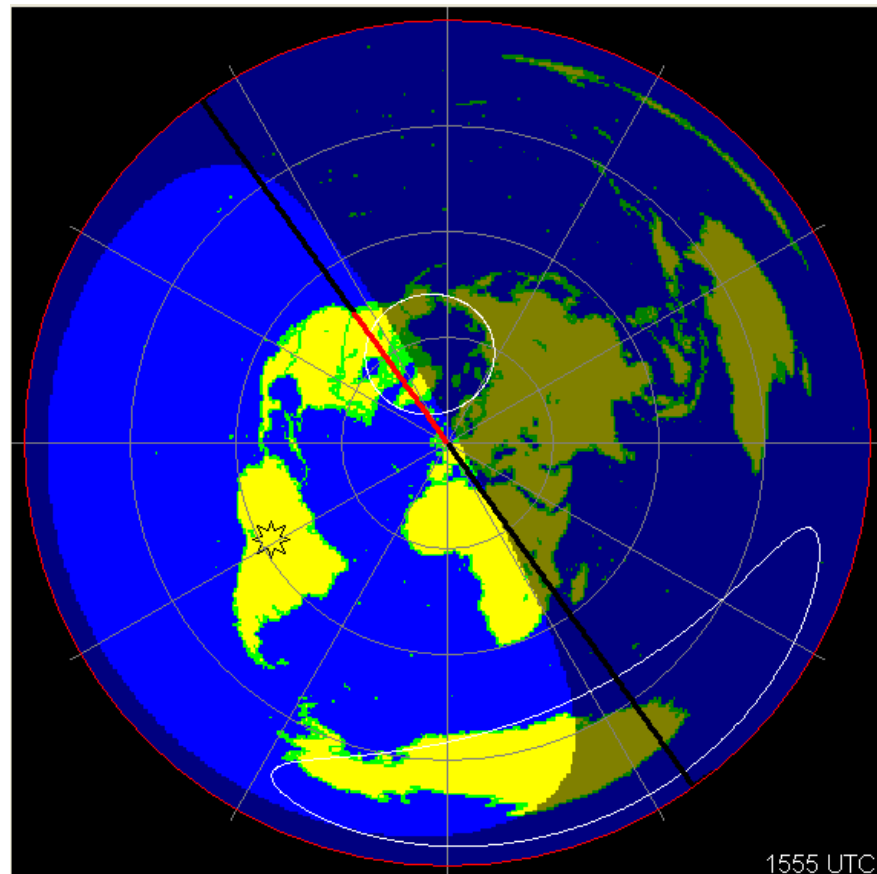
Aurora – K index is 5

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

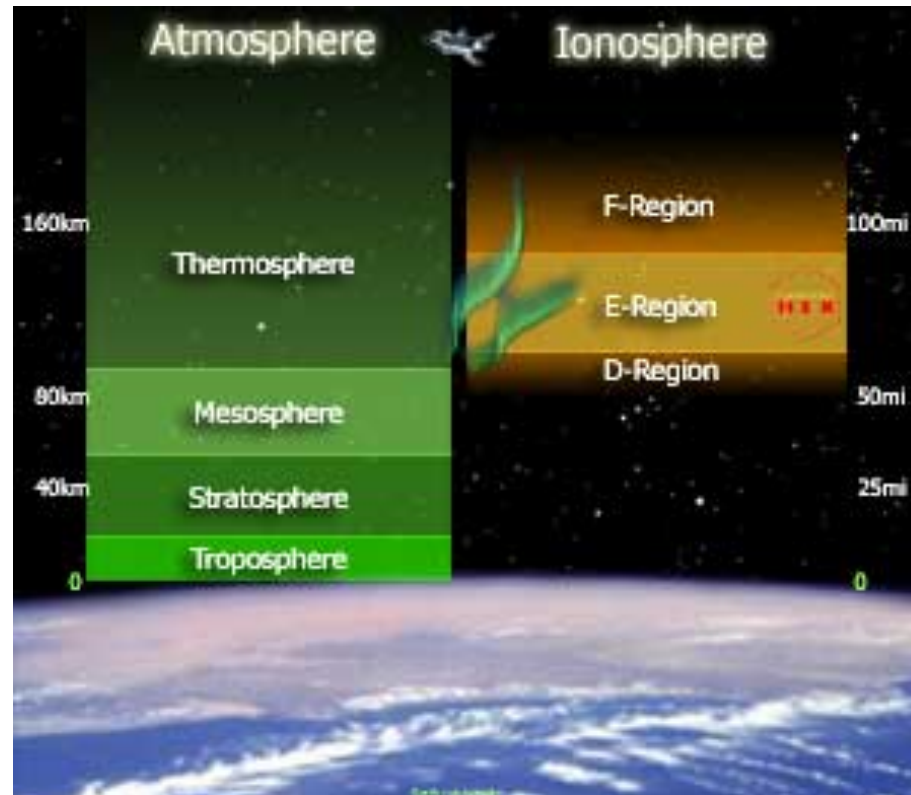
A brief run down on solar physics

- 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?

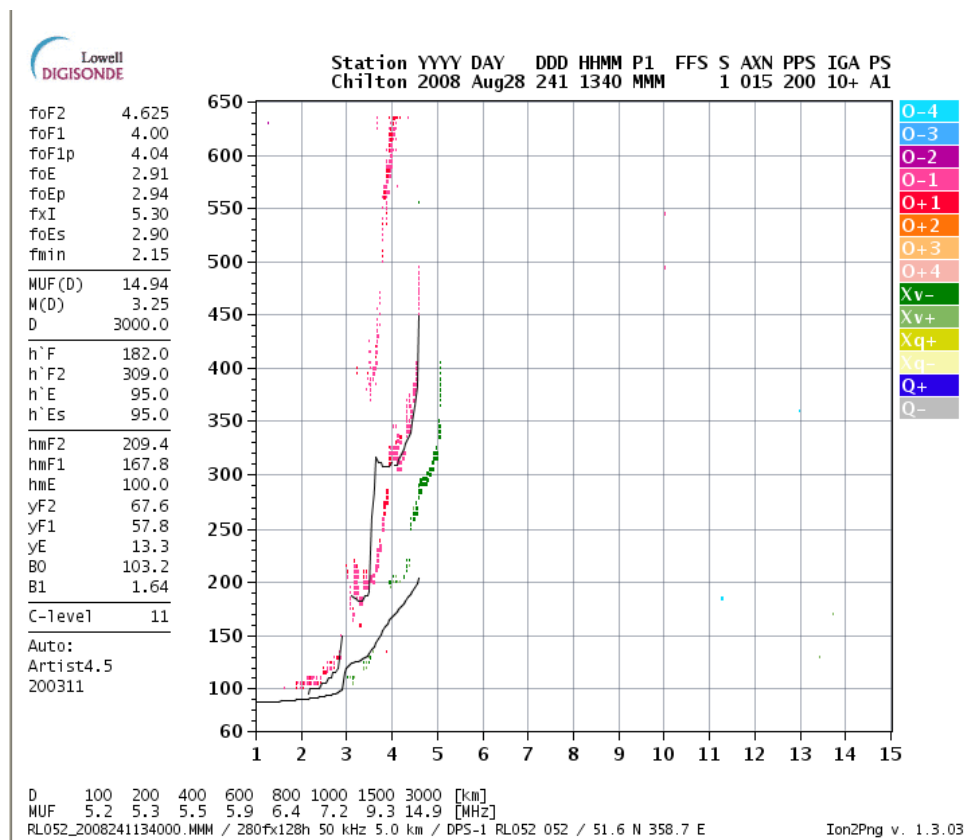
- **F-region:** The region used to propagate signals in the HF spectrum, notably 1.8MHz – 30MHz range
- **E-region:** 95-150km, contains mostly O_2^+ ions. The region used to propagate signals in the lower HF spectrum, notably 1.8MHz – 7MHz
- **D-region:** 75-95 kilometres up, relatively weak ionisation 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_oF_2 critical (straight up) frequency (4.625MHz)
- The f_oE critical frequency (2.91MHz)
- The f_oE_s Sporadic E critical frequency (2.9MHz)
- And much more

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



The D “Region”

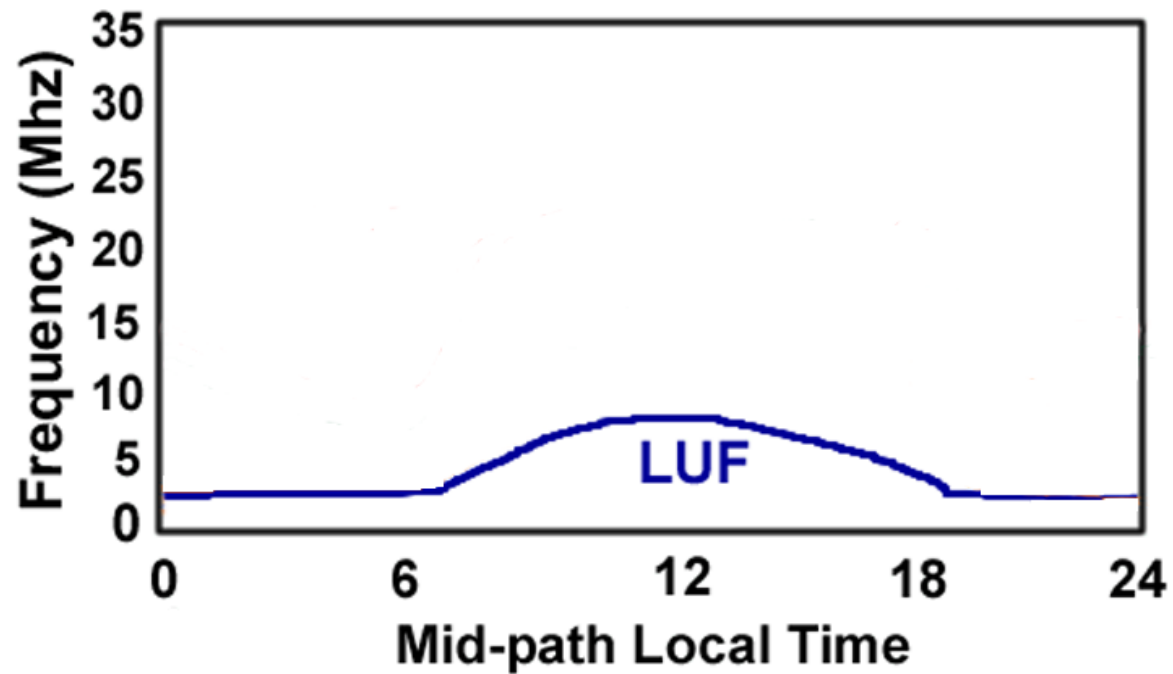
- Is at an average height of about 60-90km
- It is mainly responsible for absorbing/attenuating signals on 160-20m. It can reflect signals at VLF
- This is why we don't hear “much” skip on the LF bands during daylight, especially in summer
- The actual level of absorption is dependent upon the frequency,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

D Layer Absorption:

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

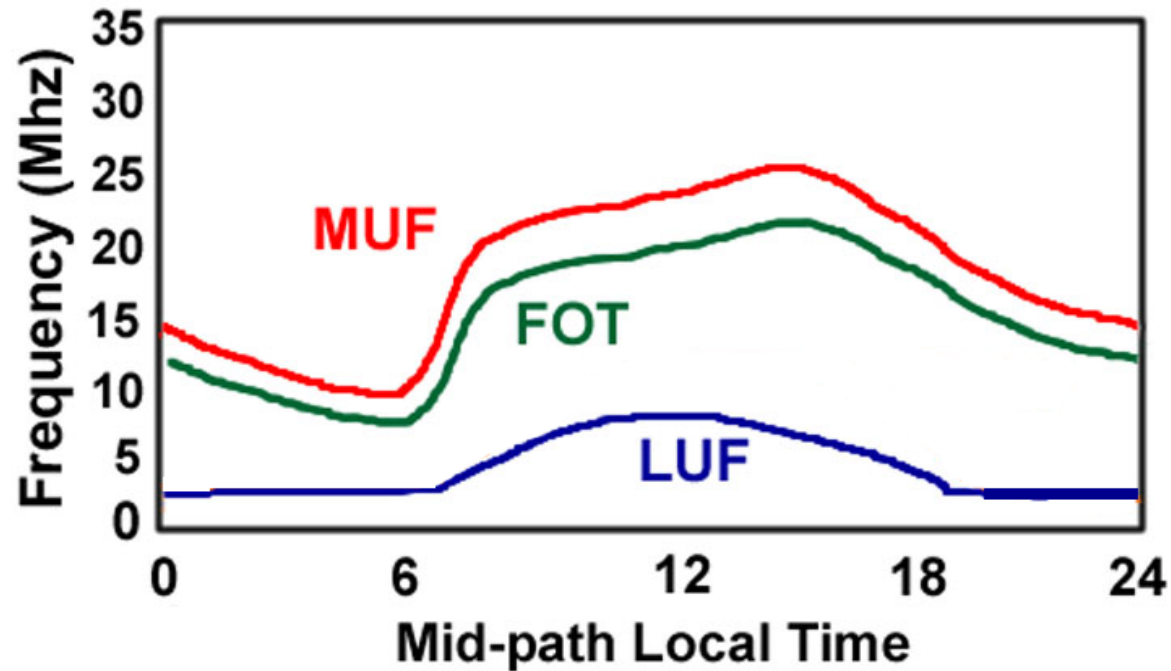
- That is, the lower the frequency, the more the absorption

Putting it all together:



The lowest usable frequency increases at sunrise

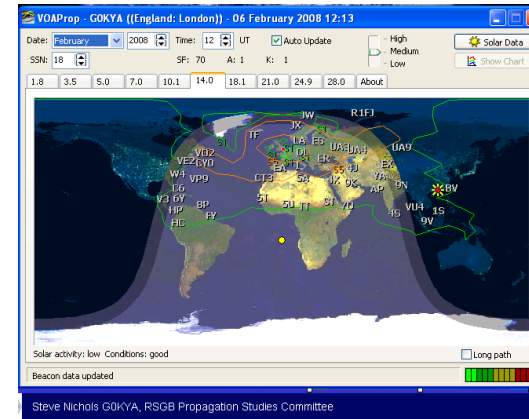
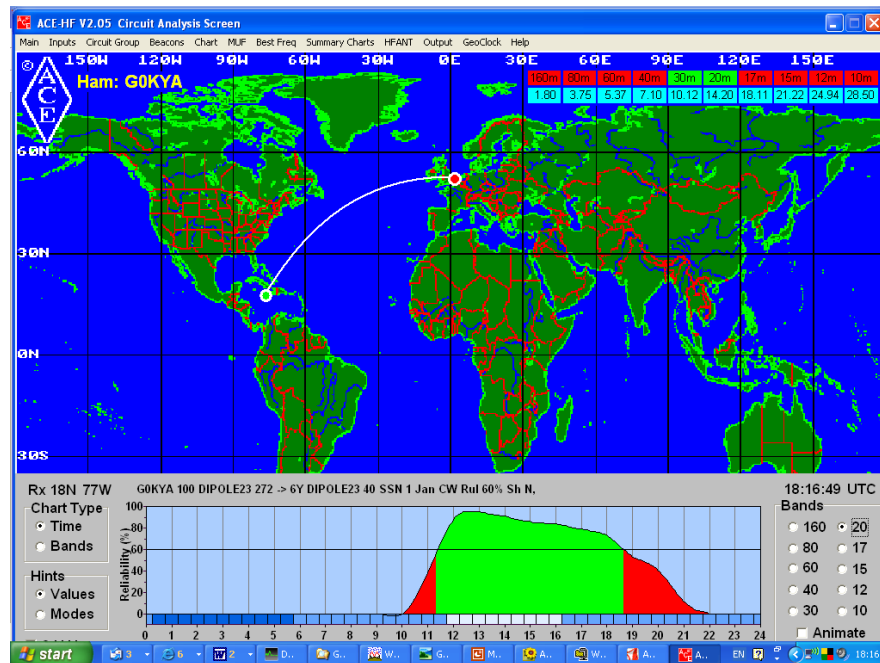
Putting it all together:



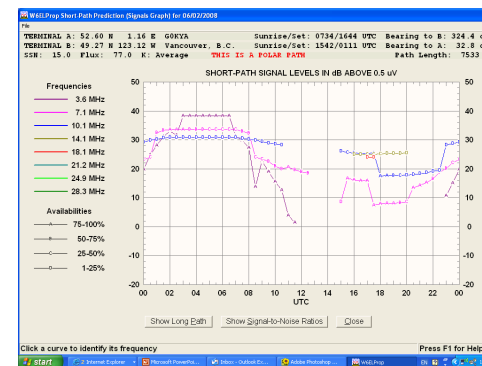
The MUF also increases – the FOT gives the highest “probability” for the contact you want to make.

Using propagation prediction programs

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

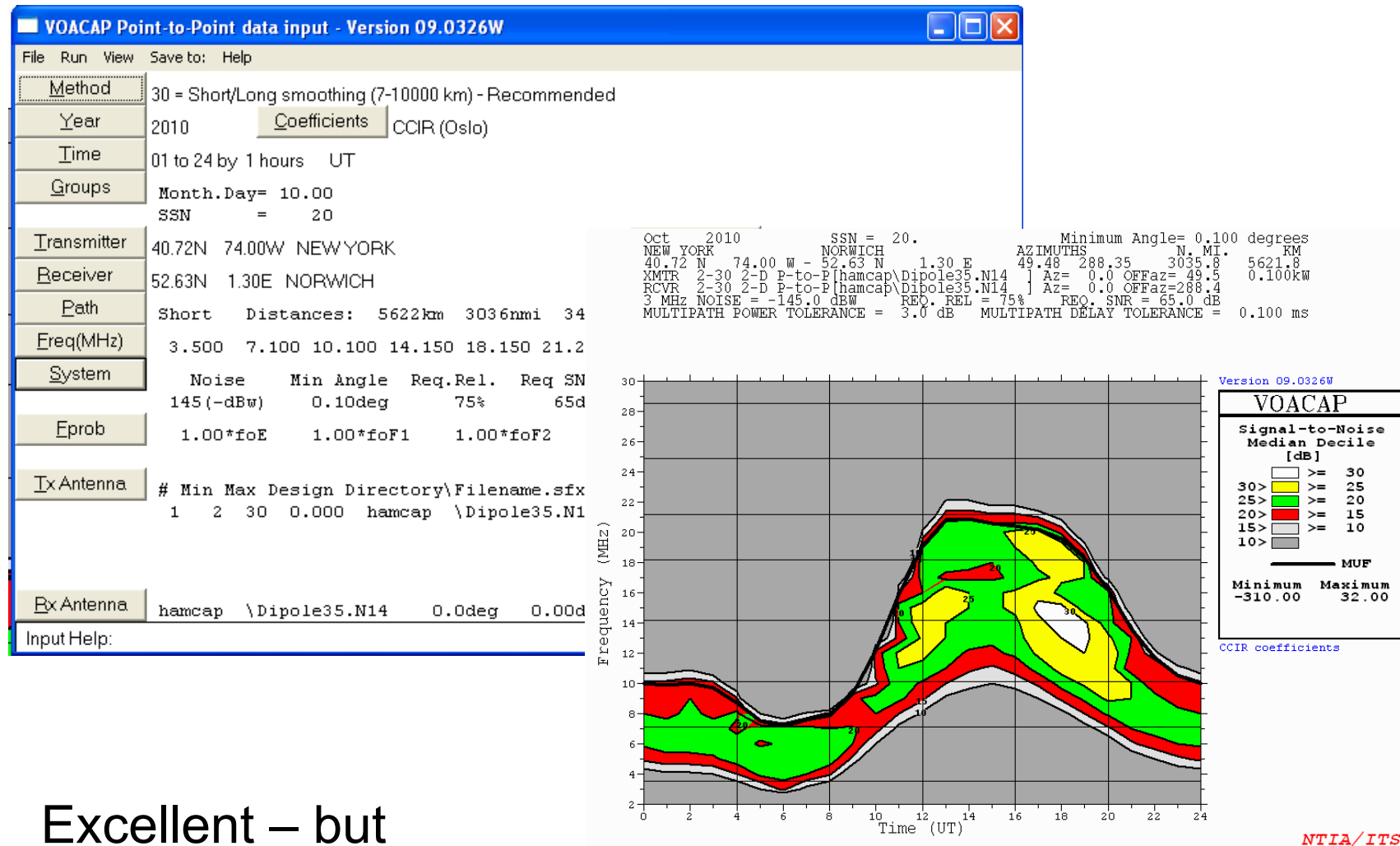


VOAProp
www.g4ilo.com/voaprop.html



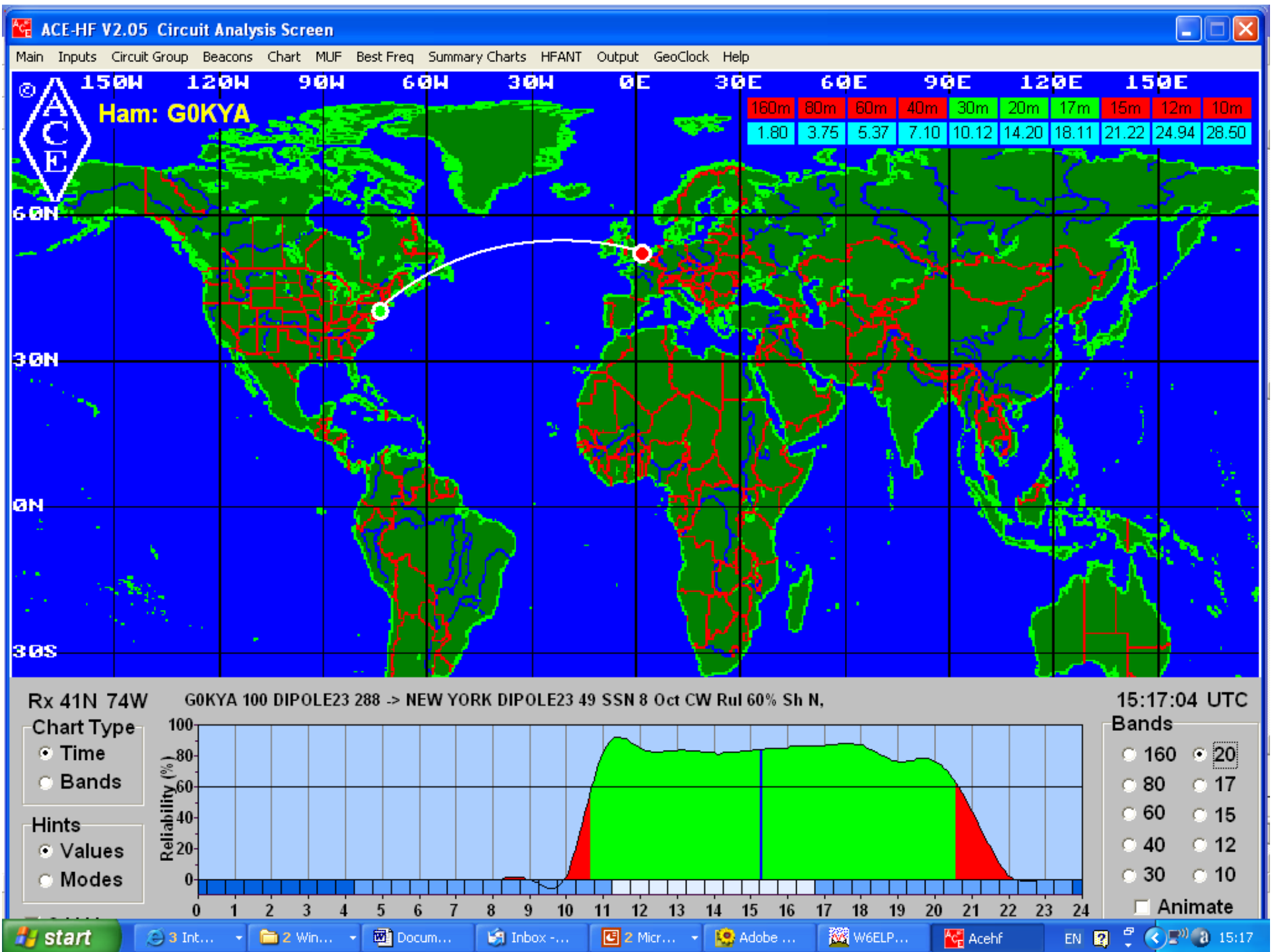
W6ELProp
www.qsl.net/w6elprop/

VOACap

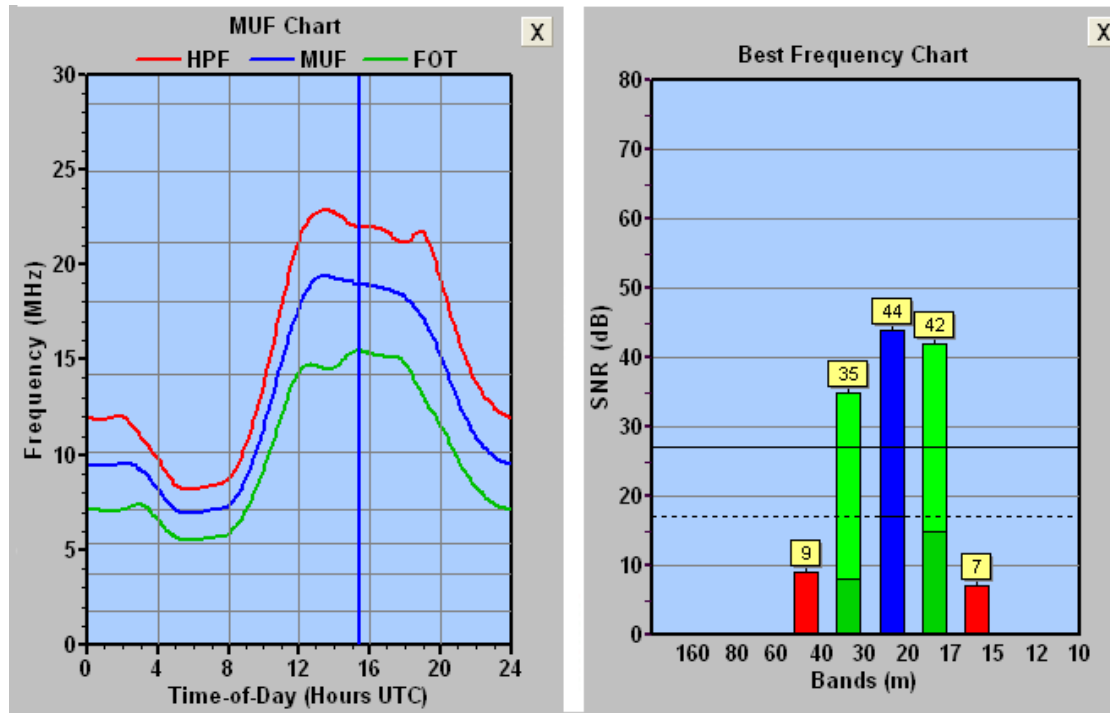


Excellent – but
not user friendly

Doesn't do well for 80m or Top band predictions



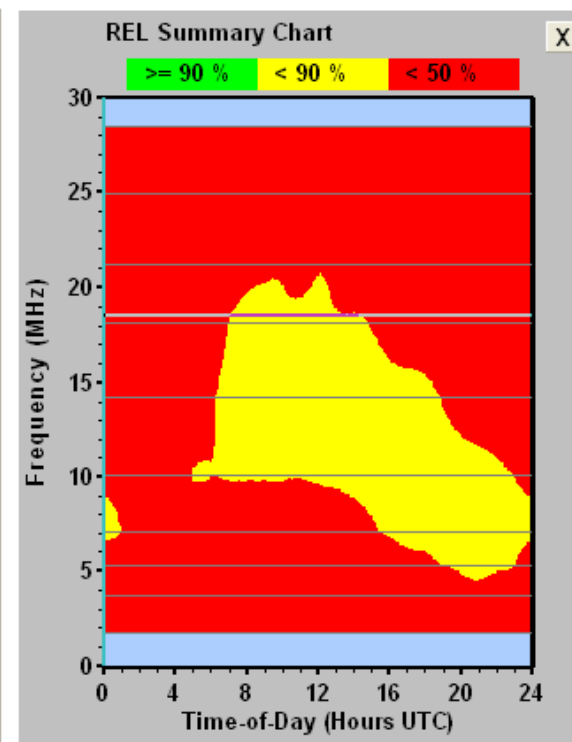
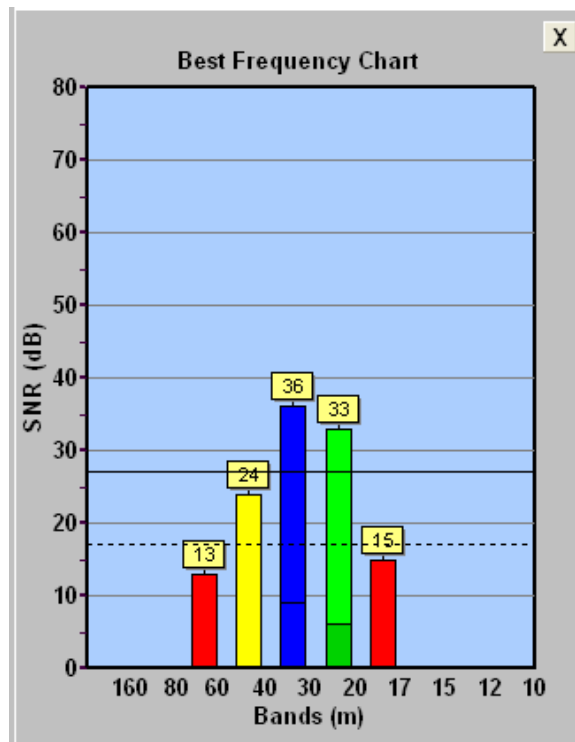
Using propagation prediction programs



- **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.

Defined Circuits for Group: G0KYA.grp

Main Inputs Area Coverage Circuit Analysis Output Help

17:10:10 UTC

	Transmitter	Receiver	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
01	G0KYA	SAN DIEGO	0	0	0	0	29	65	53	8	0	0
02	G0KYA	NEW YORK	0	0	0	1	67	80	78	20	0	0
03	G0KYA	JA	0	0	2	43	71	77	47	12	0	0
04	G0KYA	ZL	0	0	0	0	54	85	30	0	0	0
05	G0KYA	VK	0	0	0	0	54	85	30	0	0	0
06	G0KYA	HZ	0	0	35	91	100	99	95	77	1	0
07	G0KYA	VP2E	0	0	0	0	25	70	70	0	0	0
08	G0KYA	4S	0	0	0	51	91	92	91	75	17	0
09	G0KYA	3B8	0	0	0	15	84	97	92	92	75	16
10	G0KYA	PY	0	0	0	0	0	9	67	80	78	28
11	G0KYA	ZS	0	0	0	0	24	77	88	92	93	92
12	G0KYA	BY	0	0	22	67	81	83	52	9	0	0
13	G0KYA	VE7	0	0	0	7	78	86	85	29	0	0
14	G0KYA	LU	0	0	0	7	78	86	85	29	0	0
15	G0KYA	TU	0	0	0	7	78	86	85	29	0	0
16	G0KYA	KL	0	0	0	7	78	86	85	29	0	0
17			0	0	0	0	0	0	0	0	0	0
18			0	0	0	0	0	0	0	0	0	0

☐ SNR
☒ Reliability

Hour UTC 15

☐ Animate

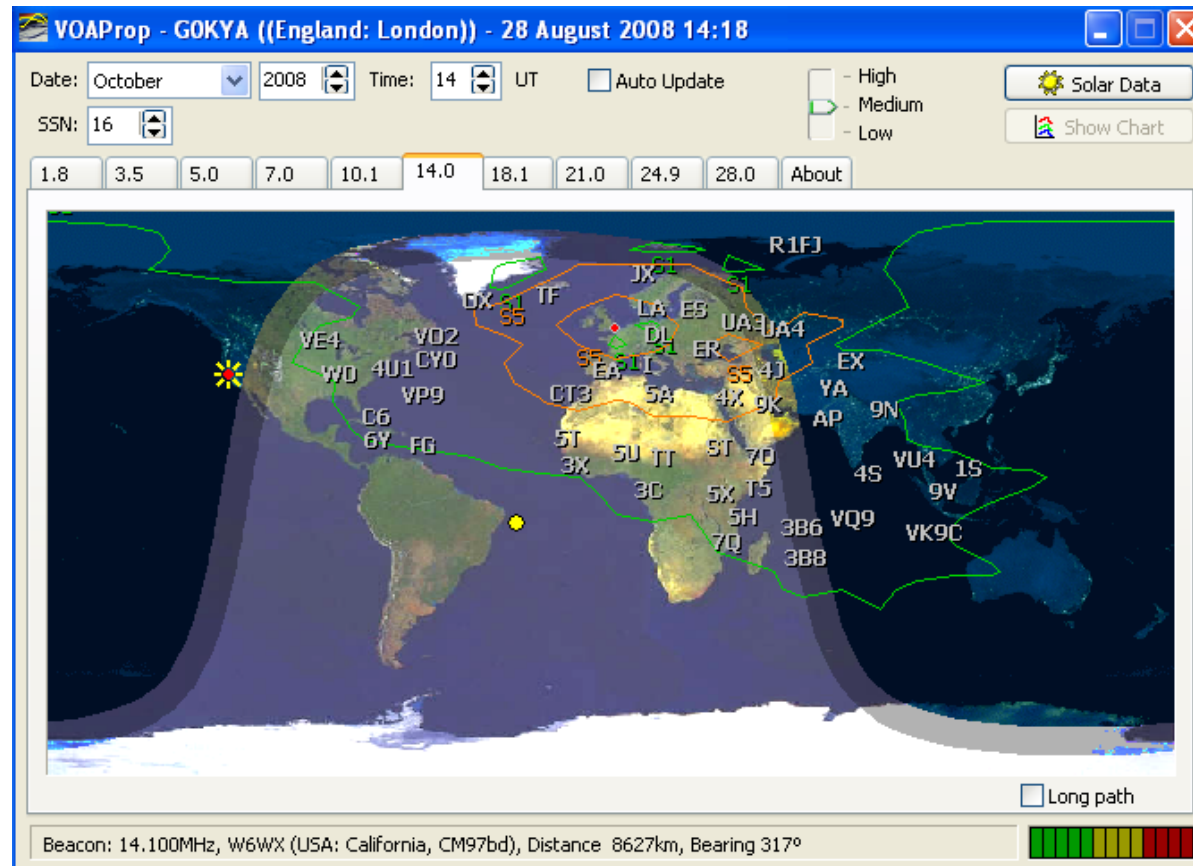
Current Time Recall Group

Run Predictions Cancel

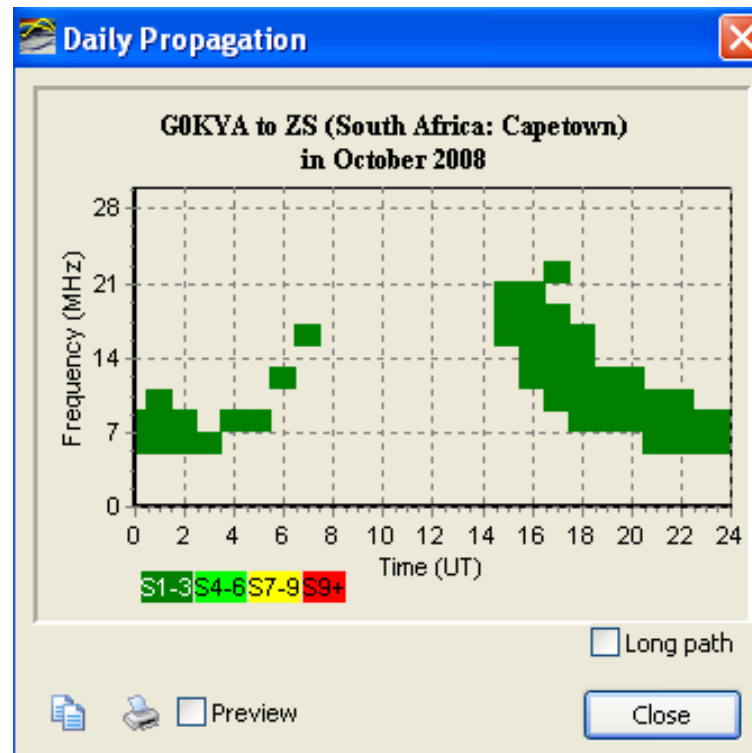
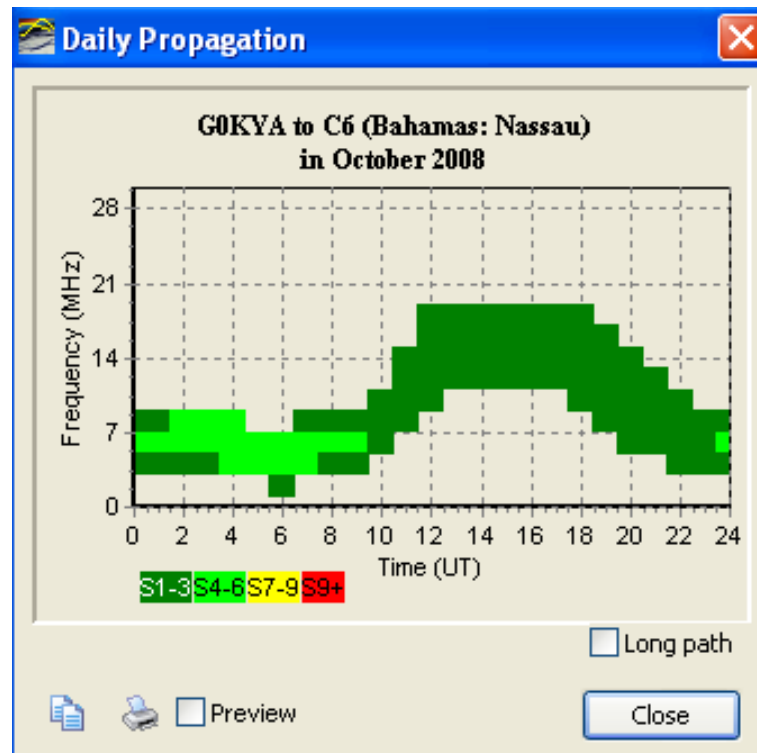
Srv Type: CW Mon: Oct SSN: 8 REL: 60% Path: Short Es: No ABS: NRM

Use propagation prediction programs

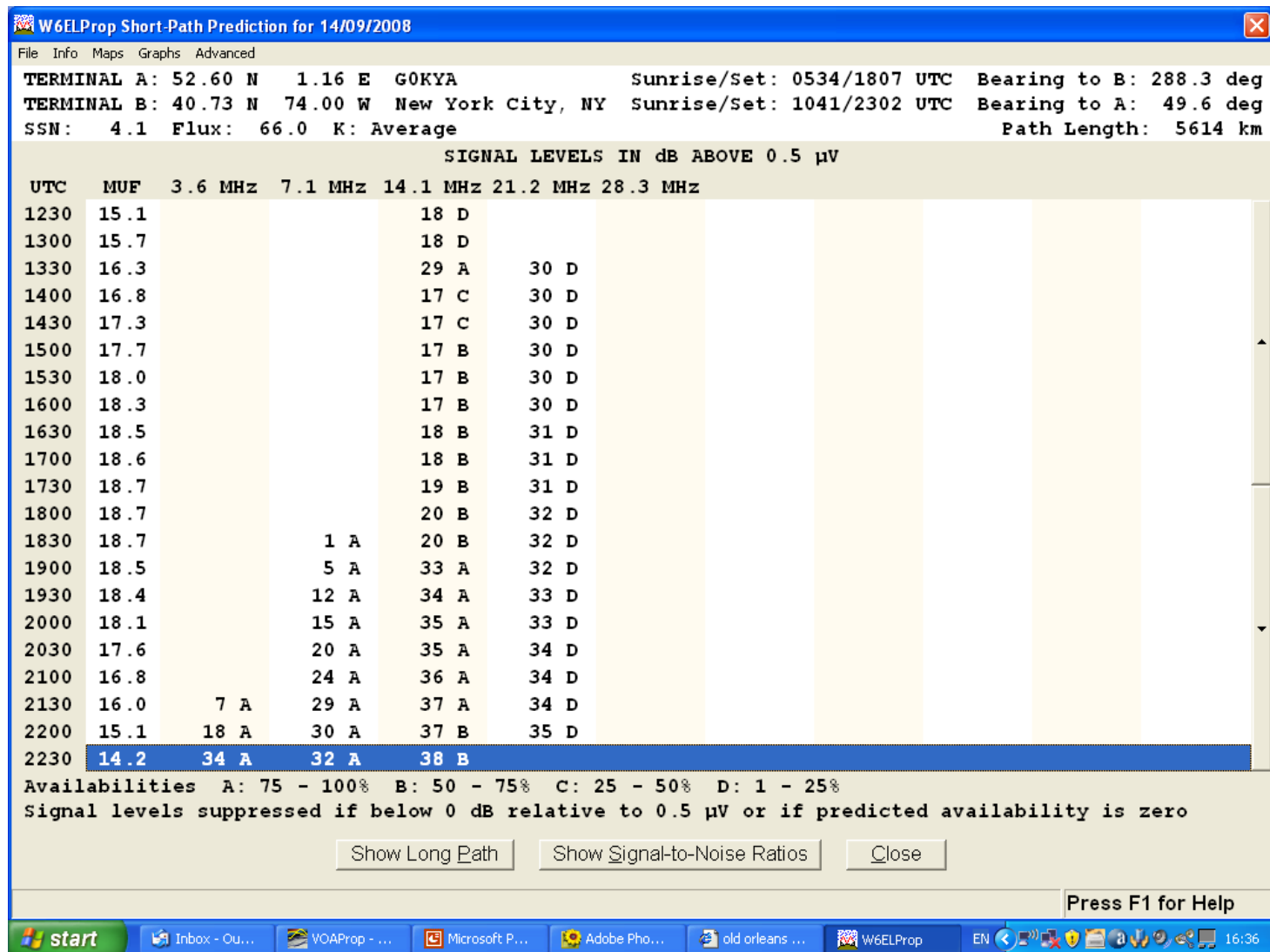
VOAProp



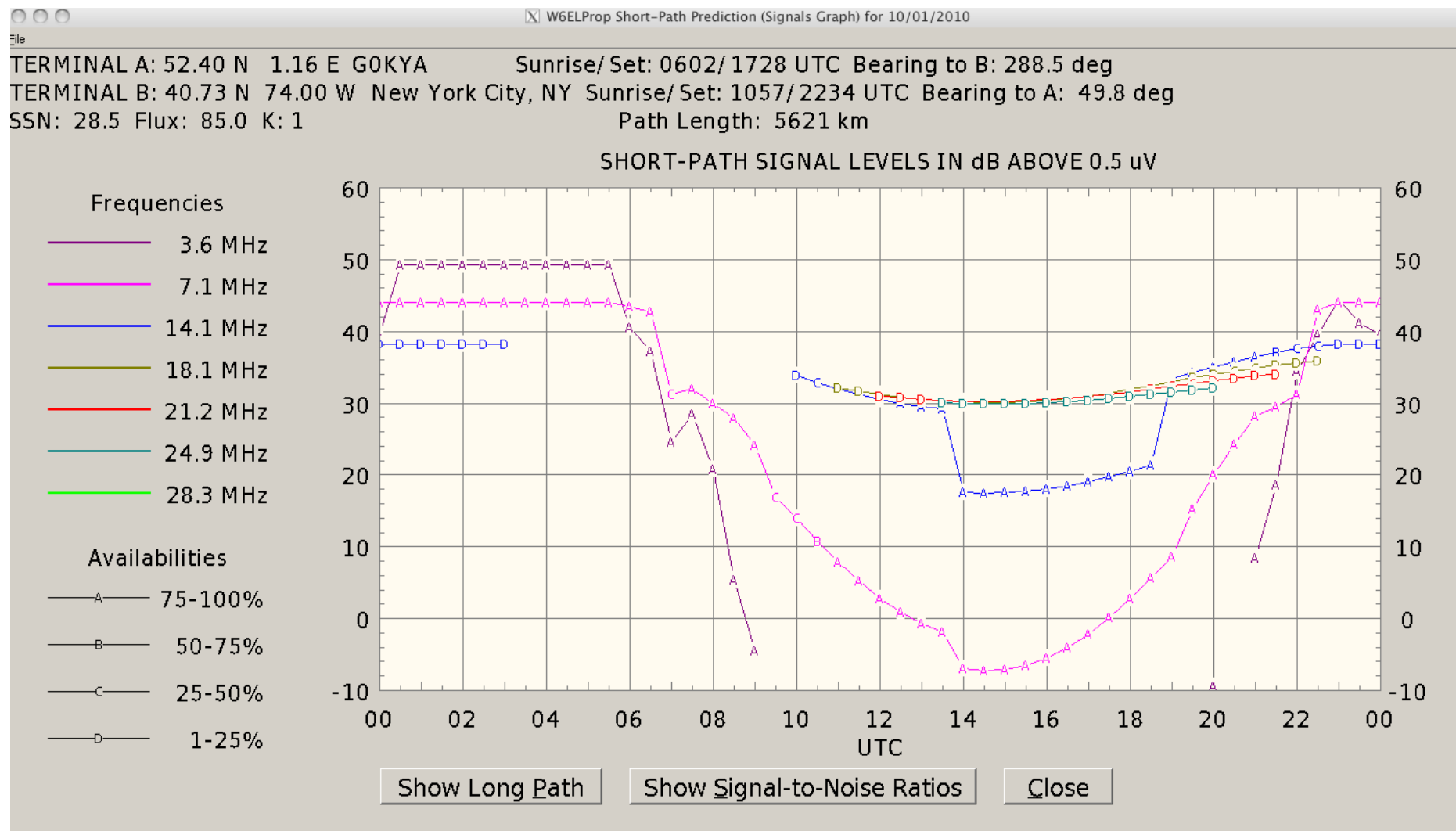
Use propagation prediction programs



VOAProp

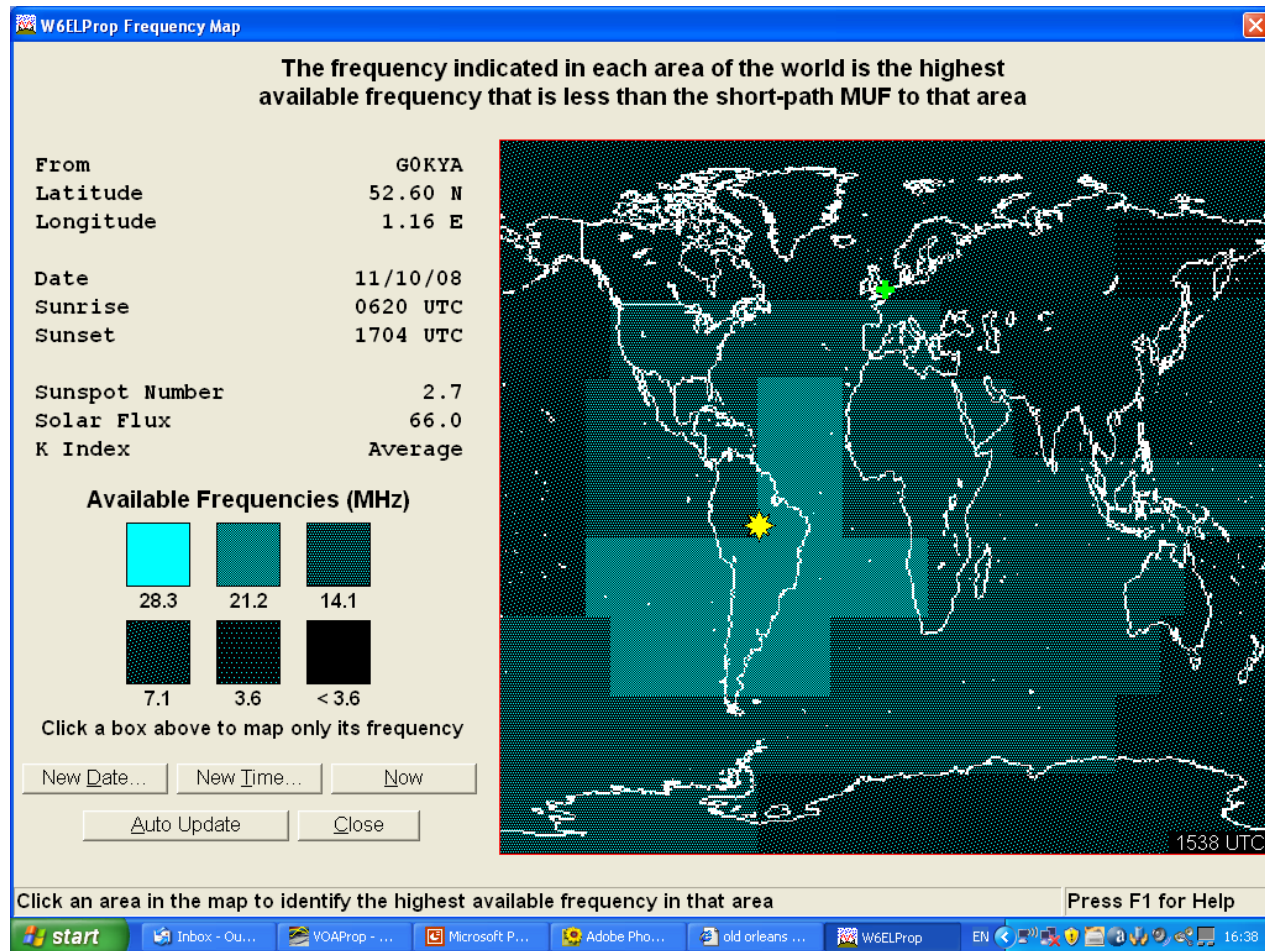


W6ELProp – can give you a table view ...



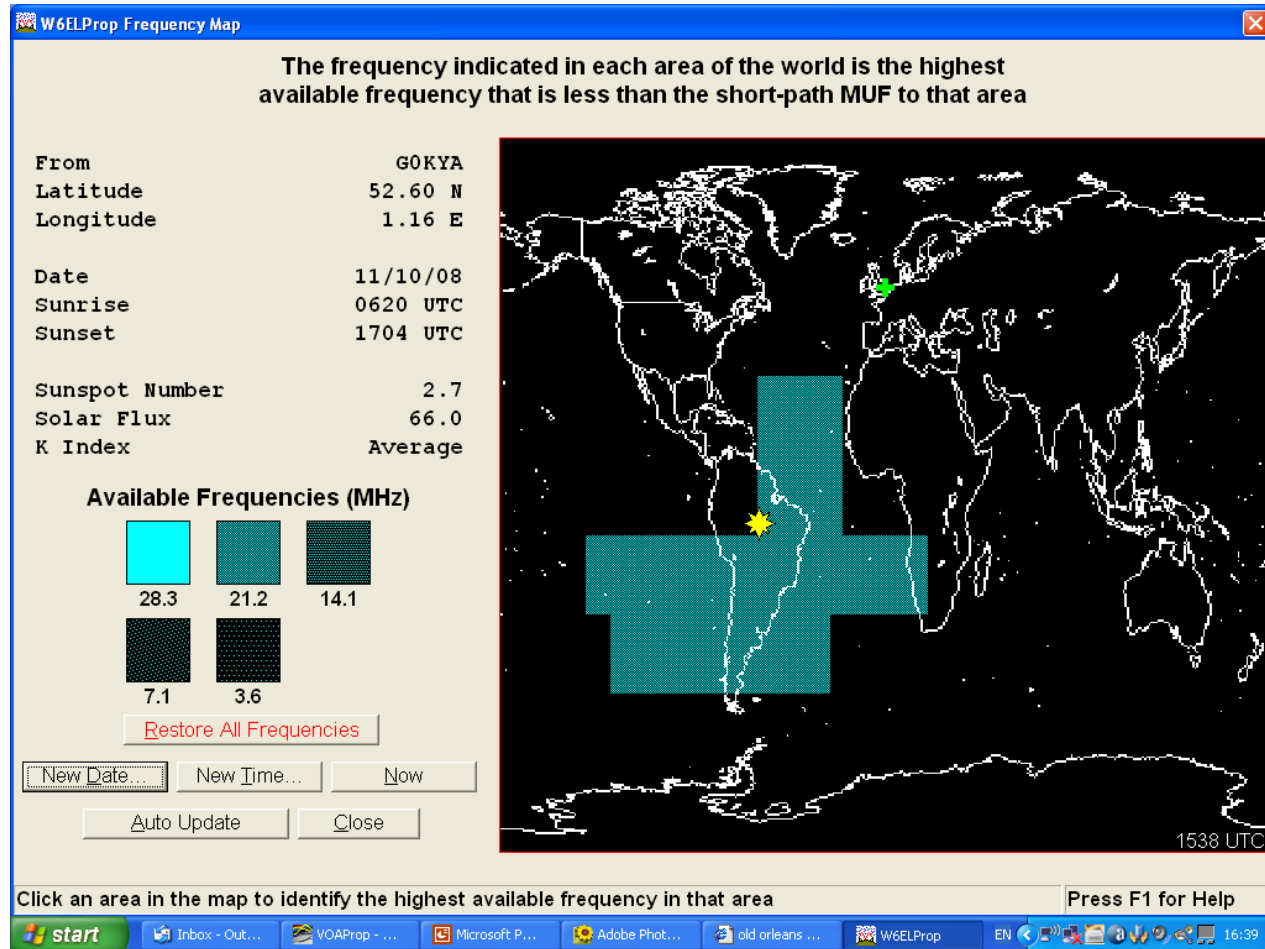
... or a graphical view

Using W6ELProp (all bands)



Its map views are a little clunky

Using W6ELProp (15m only)



Using RSGB tables

Radio Society of Great Britain | HF - Propagation Predictions from the United Kingdom - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.rs.gb.org/propagation/

Most Visited Met Office: Surface pr... IG Index Forex Strategies & Sy... Watch Air Traffic - LIVE! Arabian Aerospace cPanel X WebHost Manager - M... Author Home - Article... Authentication require...

Radio Society of Great Britain | HF - ...

The figures represent percentage probability, i.e. 1 means the path should be open between 1 and 10% of days, 2 means the path should be open between 20 and 29% of days, etc. The colours represent expected signal strength, i.e. Black = low to very low signals, Blue = fair signals and Red = strong signals.

Band	3.5MHz	7.0MHz	10.1MHz	14.0MHz	18.1MHz	21.0MHz	24.9MHz	28.0MHz
Time	000011111220	000011111220	000011111220	000011111220	000011111220	000011111220	000011111220	000011111220
(UTC)	246802468020	246802468020	246802468020	246802468020	246802468020	246802468020	246802468020	246802468020
*** Europe								
Moscow	6.....777	73.....5888	7.333.28885	..67777788..	...7776677..	.....	.....	.....
Time	000011111220	000011111220	000011111220	000011111220	000011111220	000011111220	000011111220	000011111220
(UTC)	246802468020	246802468020	246802468020	246802468020	246802468020	246802468020	246802468020	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.....4668	.....688885	.....58887	34...58888..	..885889986..	..57.76786..	...7.7..8...	.....
Time	000011111220	000011111220	000011111220	000011111220	000011111220	000011111220	000011111220	000011111220
(UTC)	246802468020	246802468020	246802468020	246802468020	246802468020	246802468020	246802468020	246802468020
*** Oceania								
Wellington	.....	.....	.....	.....	.....	.....	.....	.....
Well (NZ) (LP)	.....	66.....7..	789.....887	768.....697..	.....6..	.....	.....	.....
Perth	.....	.....553..	.....53..	.....	.....	.....	.....	.....
Sydney	.....	.....356..	.....555..	.....	.....	.....	.....	.....
Melbourne (LP)	.....	698.....	78994.....	66.78.....68	.....77	.....6..	.....	.....
Honolulu	.....	.....	53.....	.....3..	.....	.....	.....	.....
Honolulu	.....	.....	.....	.....	.....	.....	.....	.....

Done

SF:78 A:4 K:0

start Radio Society of Grea... DUBAI 2009 (E:) HF_Propagation_GOK... Dxing_small_gardens...

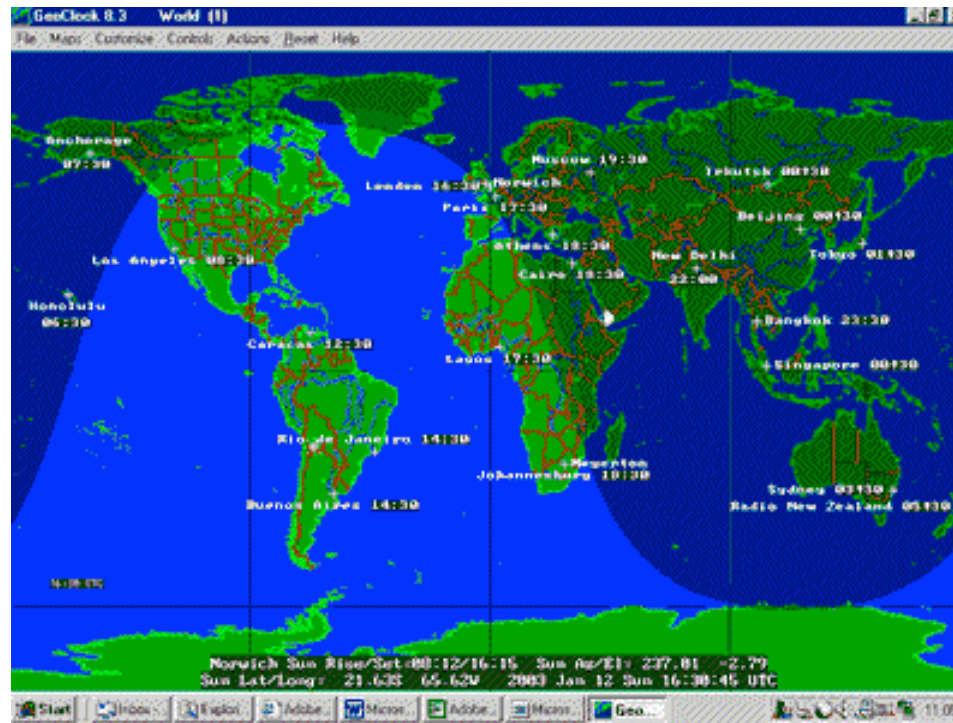
EN 16:03

You can get these from RadCom or the RSGB web site

What is “Greyline” propagation?

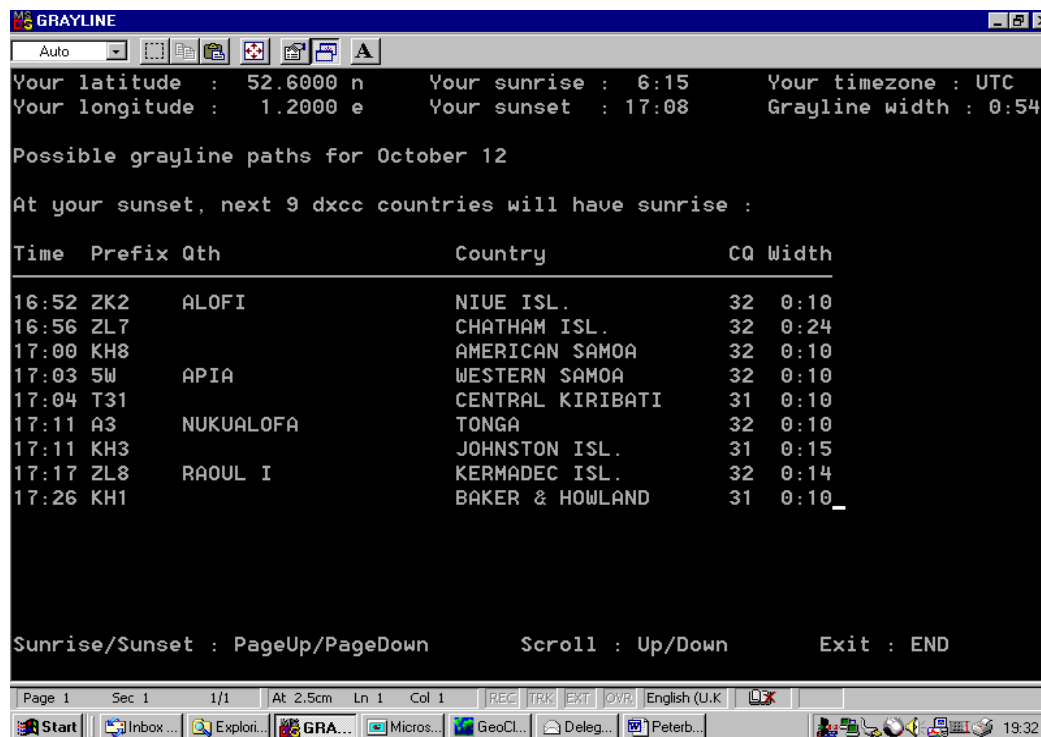
- The phrase was first coined in 1975
- It describes the propagation of radio waves **along** the terminator separating night and day (sunrise/sunset)
 - this is the “Greyline” path (or “Grayline” in USA)
- Generally, “Greyline” is commonly used to describe ANY propagation path occurring at or around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



The screenshot shows the GRAYLINE software window. The title bar is 'GRAYLINE'. Below the title bar is a menu bar with 'Auto' and several icons. The main display area shows the following text:

```
Your latitude : 52.6000 n   Your sunrise : 6:15   Your timezone : UTC
Your longitude : 1.2000 e   Your sunset  : 17:08   Grayline width : 0:54

Possible grayline paths for October 12

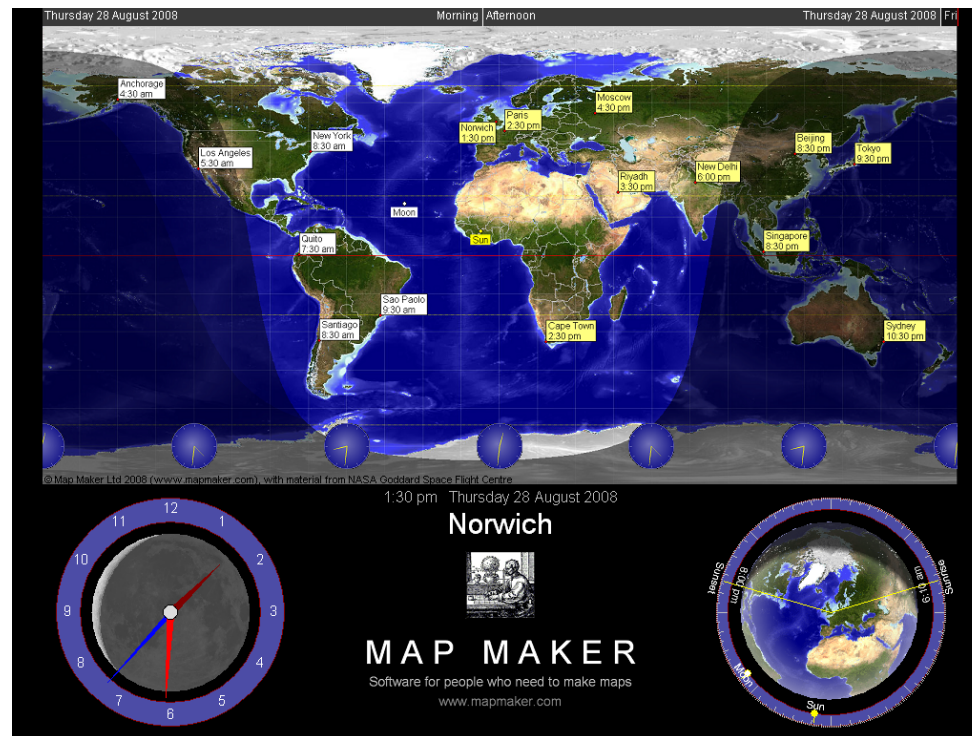
At your sunset, next 9 dxcc countries will have sunrise :
```

Time	Prefix	Qth	Country	CQ	Width
16:52	ZK2	ALOFI	NIUE ISL.	32	0:10
16:56	ZL7		CHATHAM ISL.	32	0:24
17:00	KH8		AMERICAN SAMOA	32	0:10
17:03	5W	APIA	WESTERN SAMOA	32	0:10
17:04	T31		CENTRAL KIRIBATI	31	0:10
17:11	A3	NUKUALOFA	TONGA	32	0:10
17:11	KH3		JOHNSTON ISL.	31	0:15
17:17	ZL8	RAOUL I	KERMADEC ISL.	32	0:14
17:26	KH1		BAKER & HOWLAND	31	0:10

At the bottom of the window, there is a status bar with the following text: 'Sunrise/Sunset : PageUp/PageDown', 'Scroll : Up/Down', and 'Exit : END'. The taskbar at the bottom shows the Start button and several open applications: 'Inbox...', 'Explori...', 'GRA...', 'Micros...', 'GeoCl...', 'Deleg...', and 'Peterb...'. The system clock shows '19:32'.

How do we predict greyline openings?

- With software – this is by MapMaker

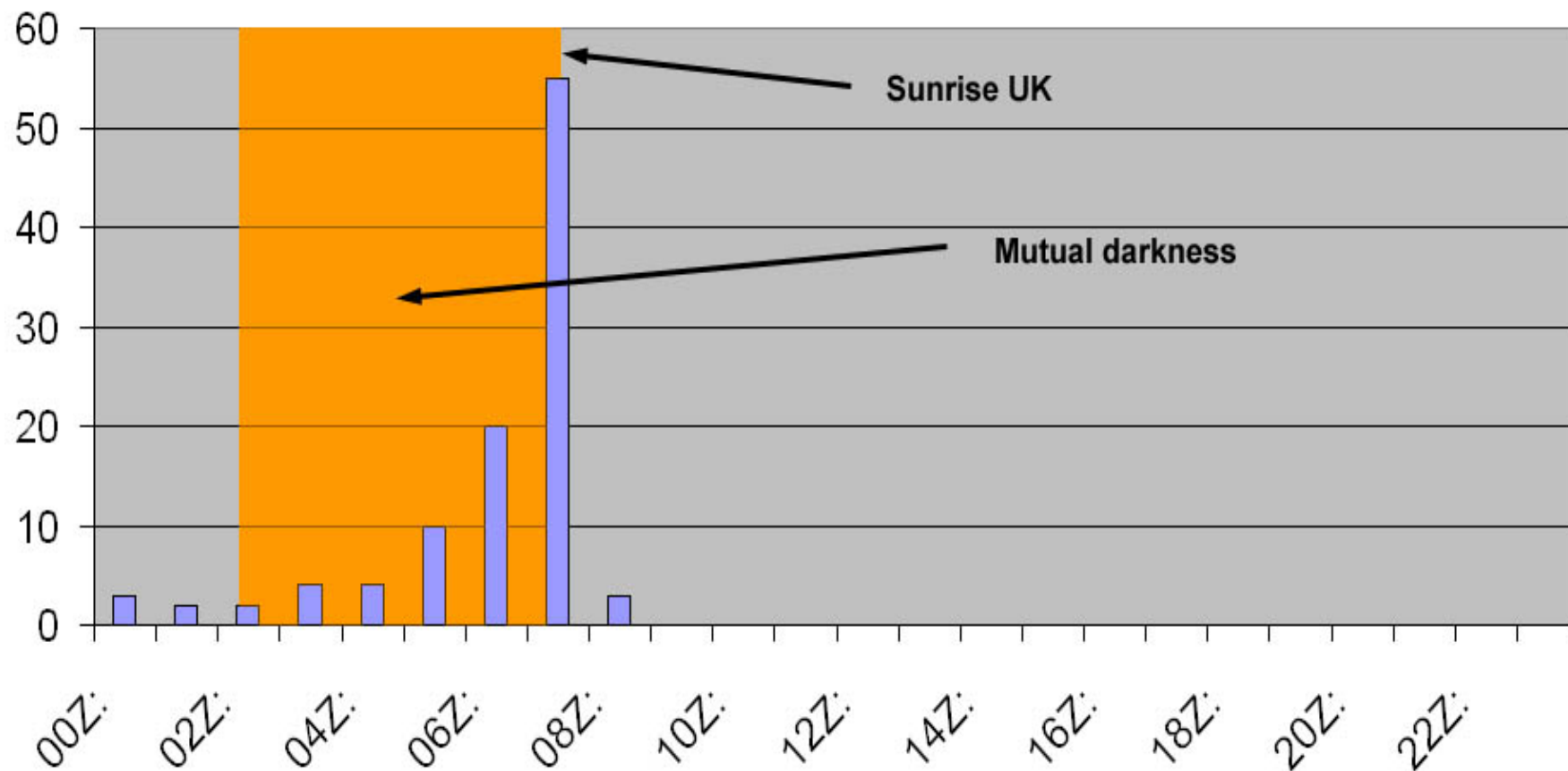


Is there a twilight “sweet spot”?

- 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)

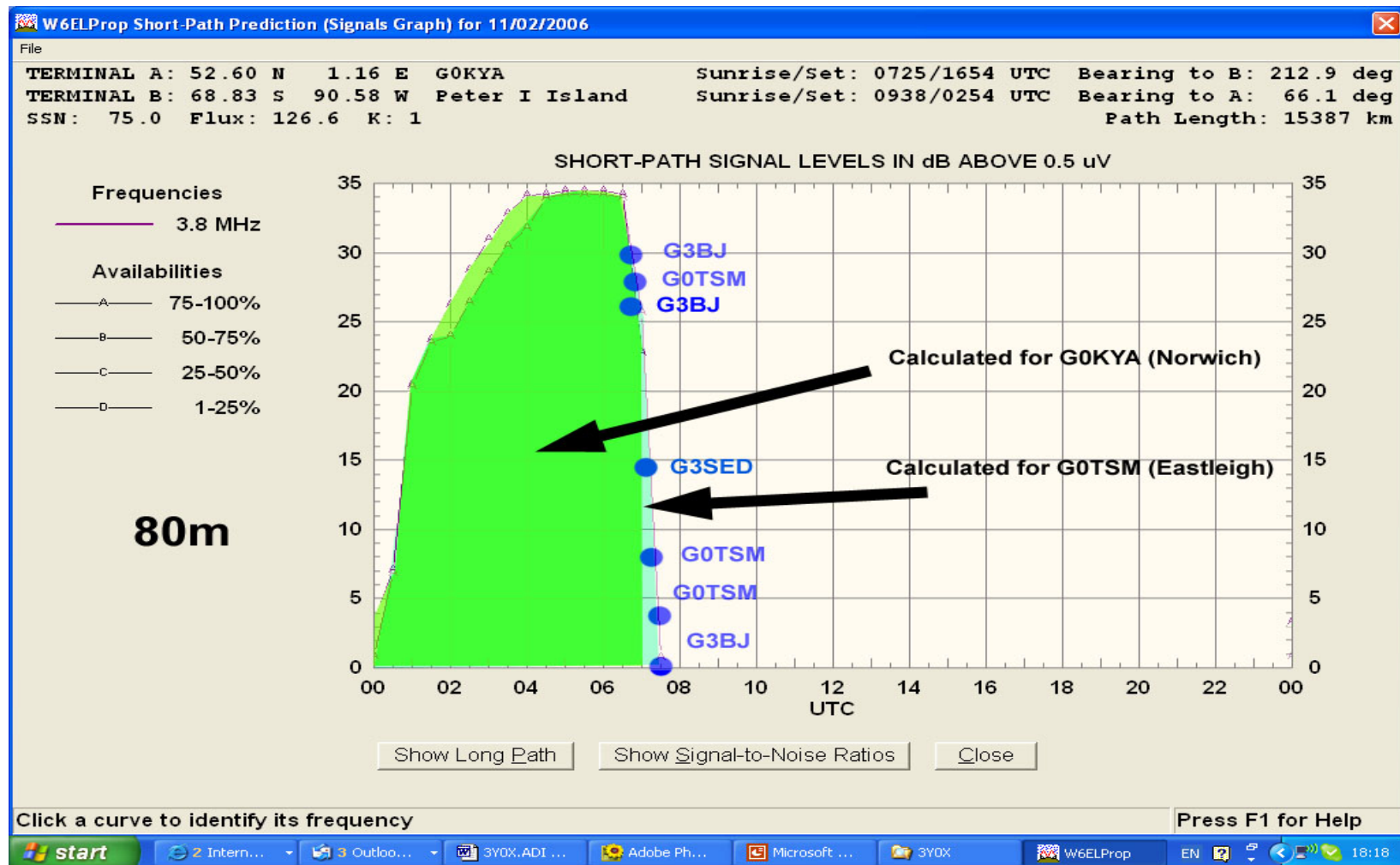
Peter 1st Island (3Y0X)

80m contacts v sunrise



Peter 1st Island (3Y0X)

80m contacts v sunrise



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.