Near Vertical Incidence Skywave Propagation
with an ARES Slant

Presented by Gil Gillingham, W1RG

Source: Rick Lord, VE4OV, **http://winnipegarc.org/NVIS_Lord.pdf**

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Adapted and updated for The SFDXA [2019 June 11] by Kai Siwiak, KE4PT

NVIS

Near Vertical Incidence Skywave

An HF Strategy for Amateur Radio Emergency Service (ARES)

Adapted for The SFDXA, with permission, 2019 April 23

Winnipeg Amateur Radio Club, Hamfest 2008, in conjunction with the Radio Amateurs of Canada (RAC) Annual General Meeting

August 2008

NVIS "Cloud Warming"

- NVIS, pronounced "*NEH*-vis" in Canada, eh?

  "*EN-vis*" elsewhere
- Used for generations
- You've probably used it on 80 m
- Your low-band signal goes straight-up and comes back and showers the general area

How Long Have we used NVIS?

- Developed during WW2
- Proven in Vietnam and Operation Desert Storm
- Used daily by Hams, but we just don't call it by its right name!
- Enjoying a "re-birth"

Why NVIS is important for ARES Operation

- NVIS uses HF, not VHF
- No dependence on VHF/UHF Repeaters
- Each HF Mobile is independent
- Massive area coverage from one station
- Not restricted to “line of sight” operation
- Low power HF operation…(5 Watts!)
- Day / Night and all-season availability

Why the Ionosphere is Important

- F2 layer is about 300 km up and acts as an “HF Reflector / Refractor”
- Your HF signal is shot straight-up and “showers” back down over a huge area
- The signal path losses for the trip up and back are so low that modest antennas and low power can achieve an S9 signal

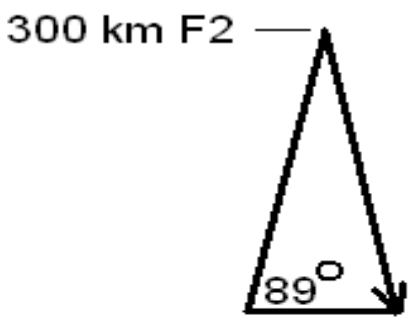
Your NVIS Signal "Showers" the Area, Out to About 1000 km

How do we shoot a signal "straight up", so that it will "shower" the area?

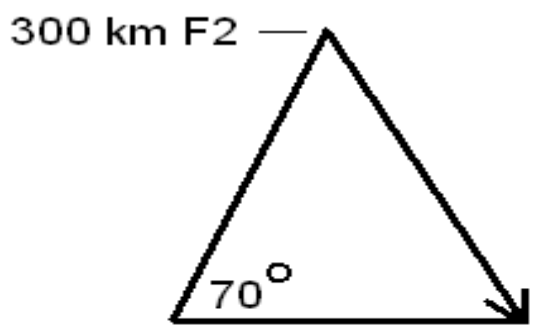
- Use a horizontal dipole or vertical loop
- Keep antenna low; 0.05 to 0.20 λ above ground
- Use 160 m, 80 m, 60 m, 40 m as required,

  depending on how high is FoF2

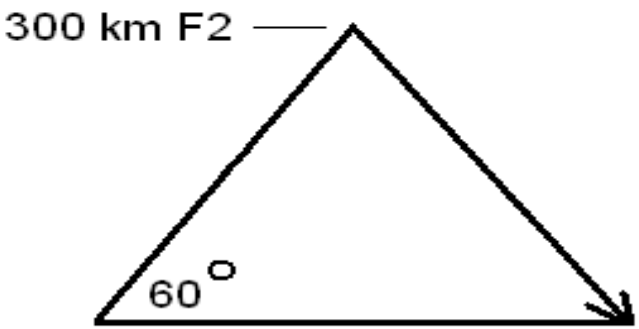
NVIS Launch Angle Examples



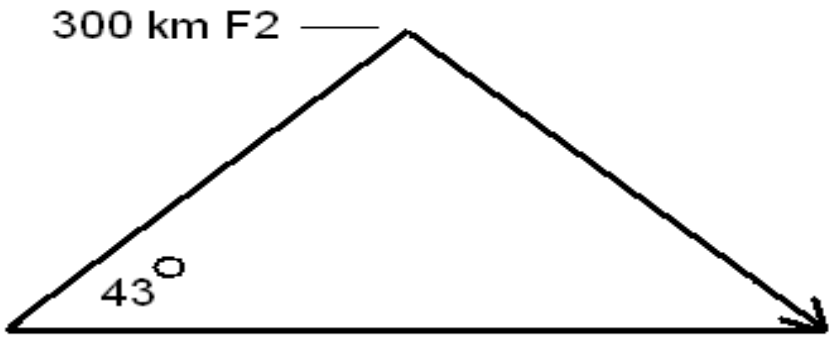
10 km, 6 miles



209 km, 130 miles

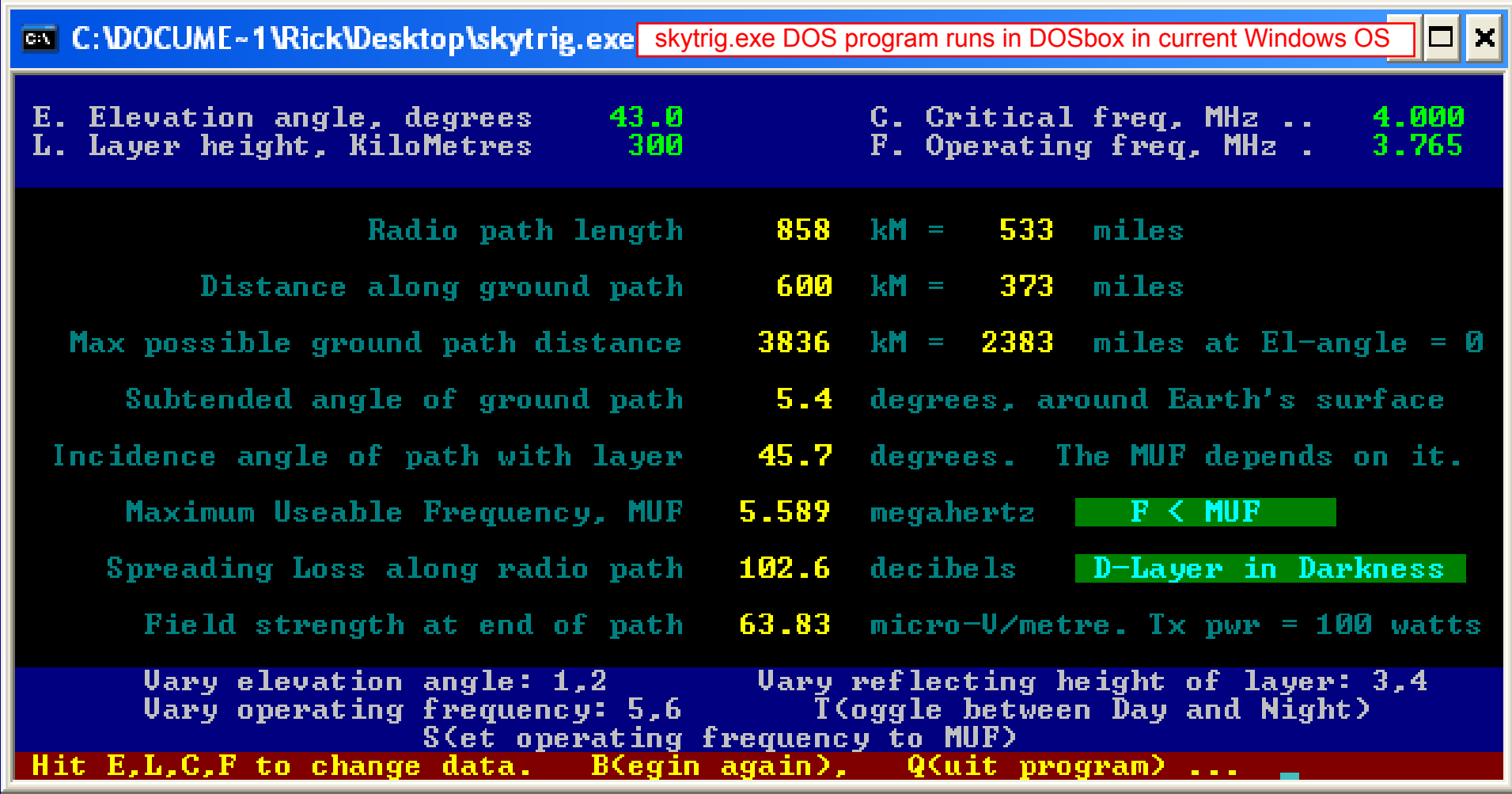


328 km, 204 miles



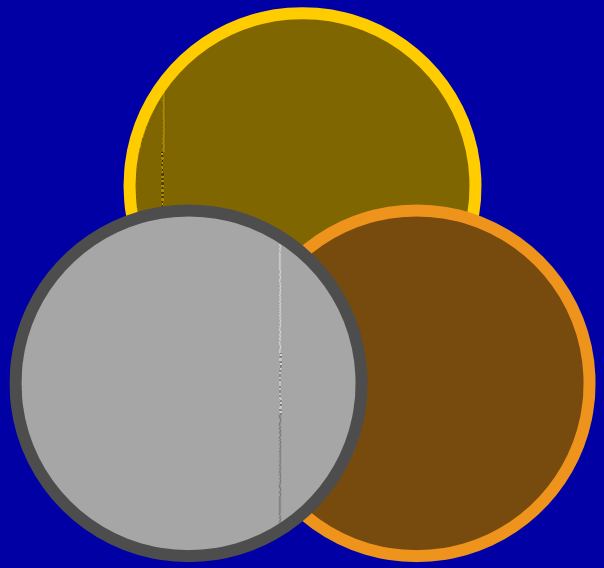
600 km, 373 miles

"*Skytrig*" for Path Calculation



NVIS is a "*Technique*"

WHAT ANTENNA HEIGHT?



WHAT POWER LEVEL?

WHAT FREQUENCY?

What Power Level?

- A “barefoot” (100 Watt) transceiver is more than enough. In fact, 5 Watts is plenty!
- A 5 W rig will give a S9 to S9+ signal to a similar NVIS Station
- The worst-case path loss is in the 99 dB to 111 dB range for 1000 km
- This means that low-power rigs can handle the job - good news for portable ARES ops

Example: 5-W rig over 1000 km ground path via the F2 Layer at a 300 km height

Freq. MHz	Path Loss dB	Received Power dBm	Urban Noise Level dBm	Signal to Noise Ratio
1.875	-99.4	-62.4	-84	+ 21.6
3.750	-105.4	-68.4	-93	+ 24.6
7.150	-111.0	-74.0	-101.5	+ 27.5

This example assumes that both the transmitting antenna and the receiving antenna are isotropic radiators with Gain = 0 dBi. Also assumed is that any transmission line losses are 0 dB at both ends of the link.

What Antenna Height?

- A Horizontal dipole or vertical loop about 0.05 to 0.25 λ above ground is required
- Higher is *not* better
- Depending on the ground conductivity below your NVIS antenna, a 0.2 λ height is about optimum
- Lowering your NVIS antenna *improves* your Signal to Noise Ratio

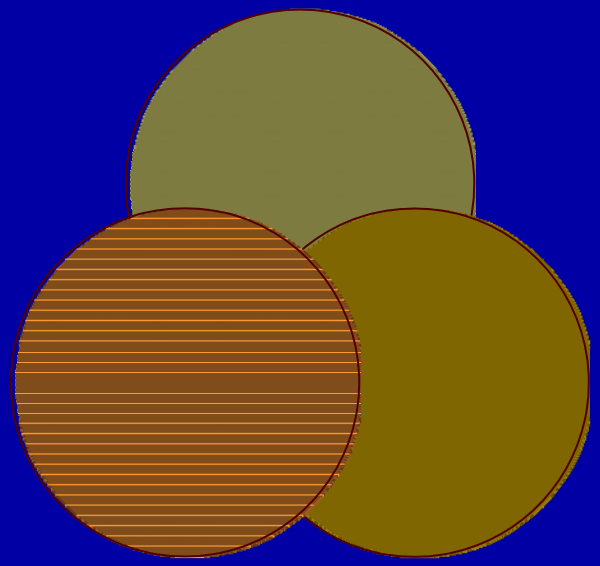
What Frequency?

Ah, yes! Here's where the "*Technique*" part comes in:

- One of the 4 "Low Bands" is the correct choice - 160 m, 80 m, 60 m, 40 m
- NVIS techniques are restricted to the "Low Bands", so forget about 20 m, 15 m, and up

What Frequency?

IS IT DAYTIME OR NIGHTTIME ?



SOLAR FLUX ?

FoF2 ?

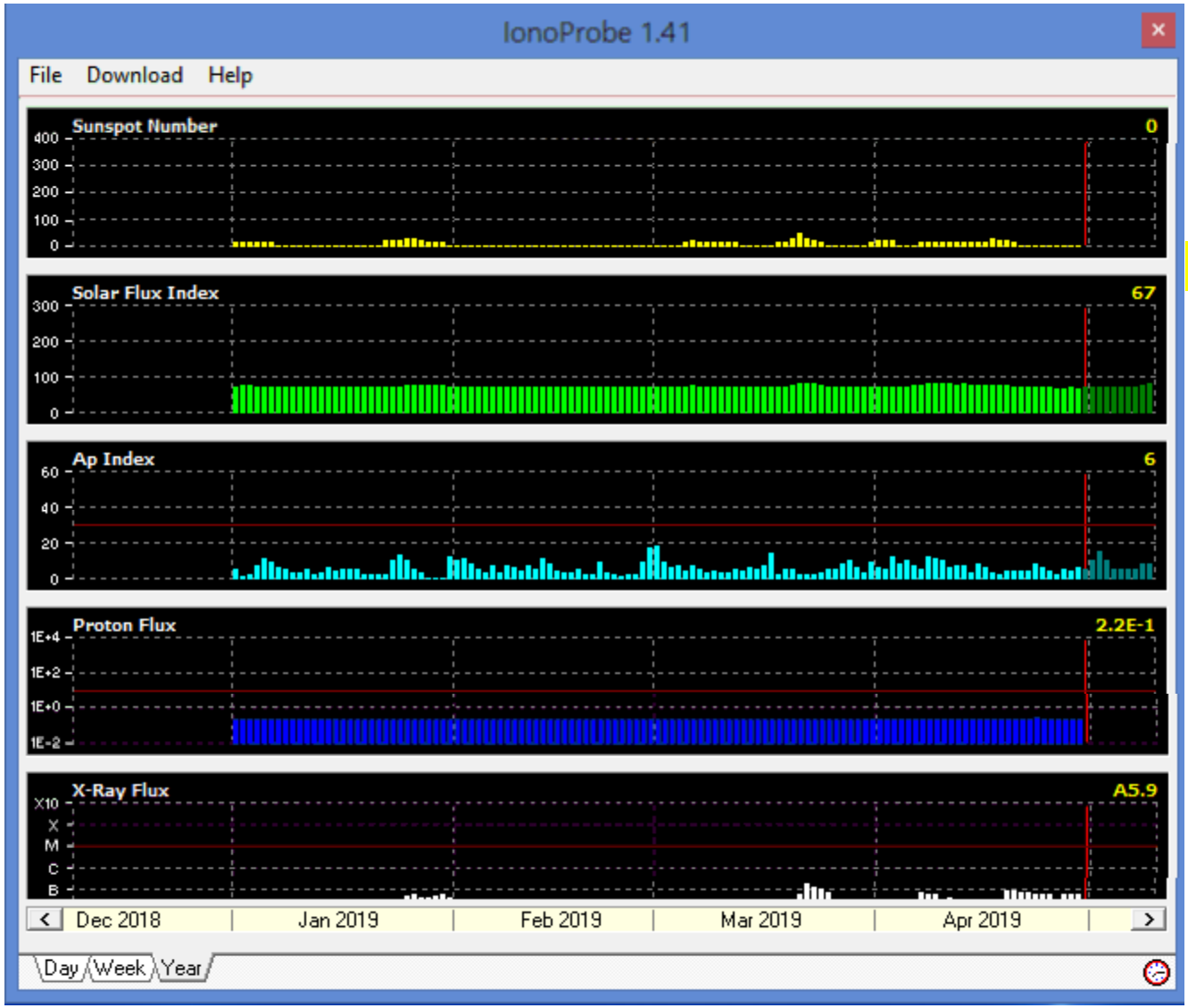
Is it Day Time or Night Time?

- 160 m is useless during the daytime, due to D-Layer Absorption; *Use 160 m at night!*
- 80 m is adequate during the daytime; Better around dusk, dawn and night time
- 40 m is your best bet for daytime *if FoF2 is high enough*

Solar Flux?

- Pick up the latest Geophysical Alerts, including Solar Flux, from the internet, or from WWV at 18 minutes after every hour
- Solar Flux is the amount of energy received from the Sun on the 10.7 cm band
- Solar Flux is a measure of Sunspot Activity, and hence an indicator of propagation

IonoProbe: State of the Ionosphere



Sunspot Number

Solar Flux Index

Ap

Proton Flux

X-ray Flux

Dec 2018 – May 2019

FoF2

- FoF2 is the *Critical Frequency* of the F2 Layer. This is the highest frequency that the F2 Layer will return to earth when RF strikes it vertically, that is, “Straight-Up”

- You can get the latest hourly FoF2 from the internet, or from WWV

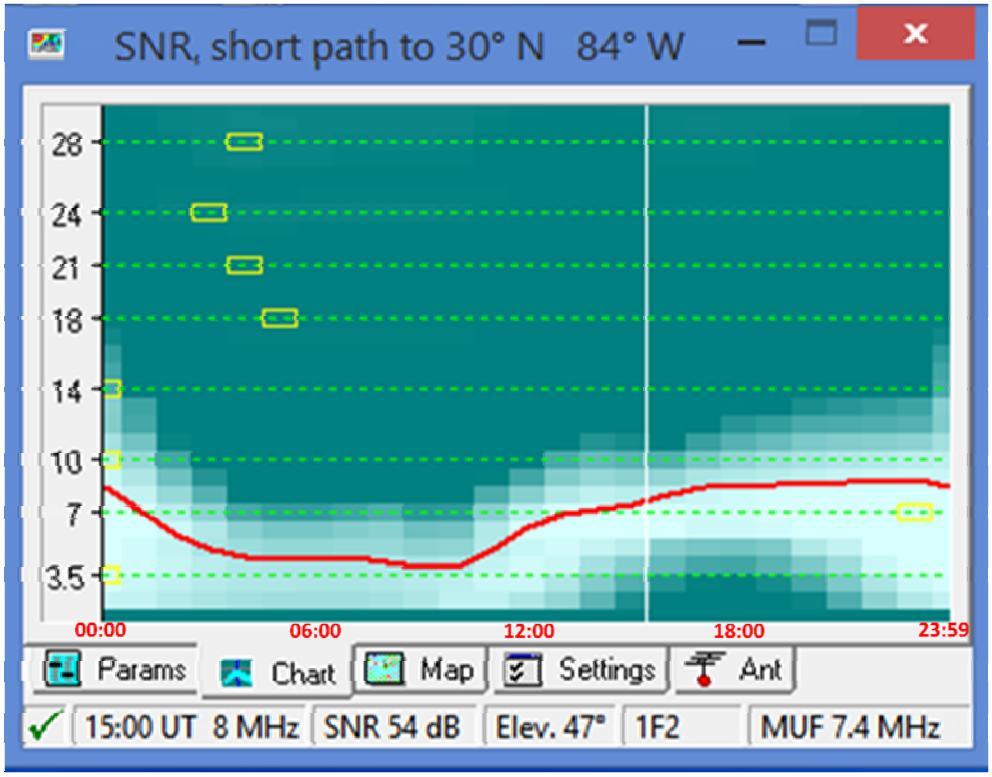
See also: http://www.sws.bom.gov.au/Images/HF%20Systems/Global%20HF /Ionospheric%20Map/WorldIMap.gif

The HAP Chart

- Hourly Area Prediction charts are available from the Internet. A HAP Chart plots the FoF2, or *Critical Frequency;* this is a *crucial* piece of information for NVIS ops!

- The FoF2 varies during the day, night, seasons, and Sunspot Cycle; to establish reliable NVIS Communication, you need to know its value

HAMCap 1.91 MUF



MUF over a 24 hour period on April 30, 2019

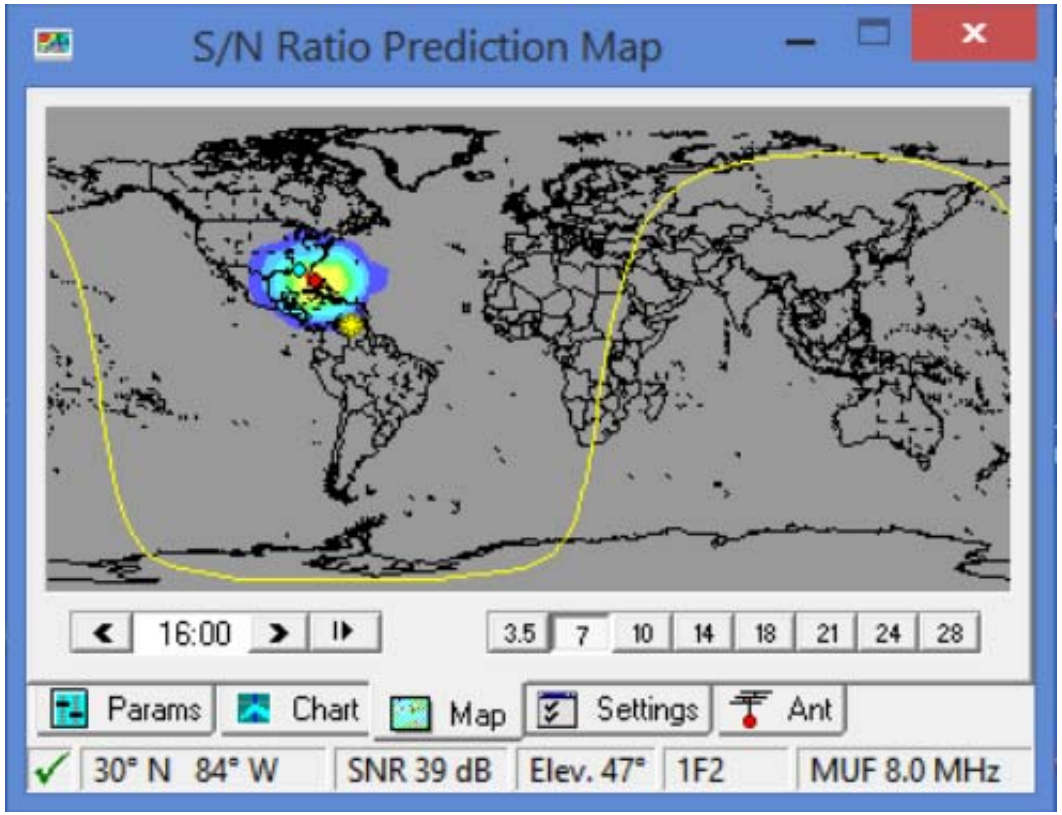
For the F2 layer path

K4FK to Tallahassee, FL

Note:

- 47° elevation angle
- 54 dB SNR at 1 kW
- which is 31 dB at 5 W!
- [SSB needs SNR > 10 dB]

HAMCap Area Coverage



Area Prediction

at 7 MHz, 16:00 Z

For the F2 layer path

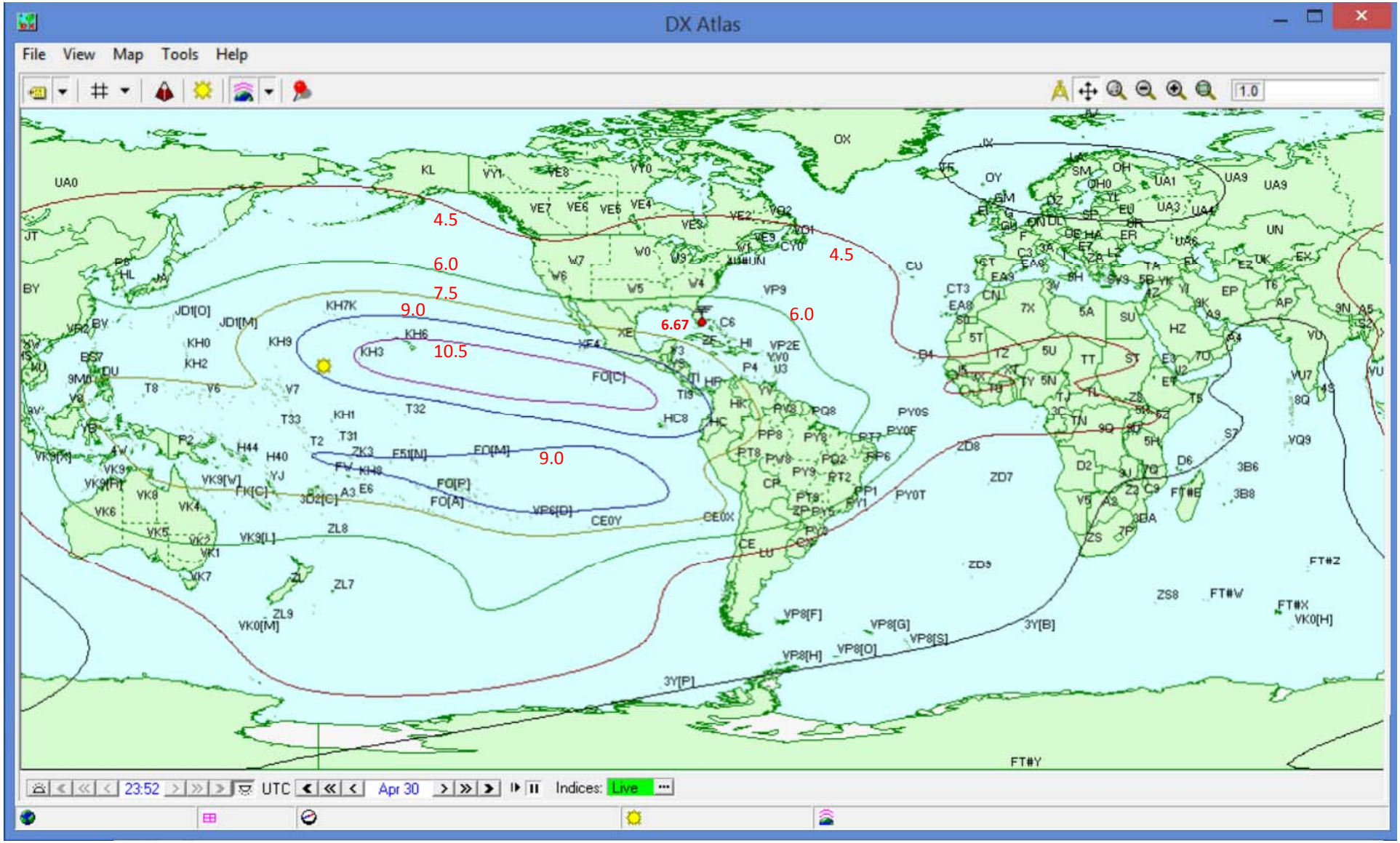
K4FK to Tallahassee, FL

Note:

39 dB SNR at 5 W!

[SSB needs SNR > 10 dB]

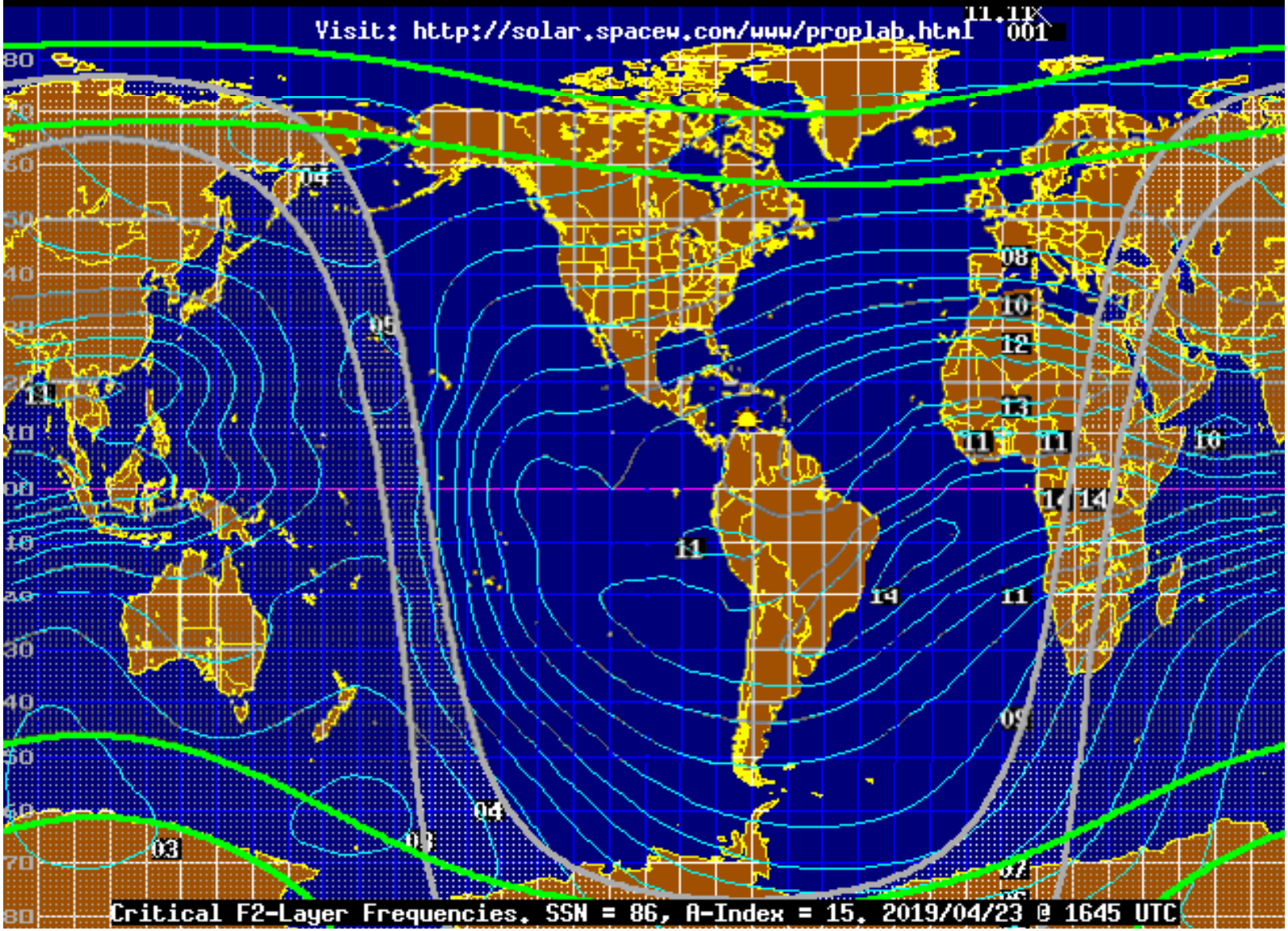
DX Atlas F2 Critical Frequency



see also: http://www.sws.bom.gov.au/Images/HF%20Systems/Global%20HF/Ionospheric%20Map/WorldIMap.gif

NEW Proplab for Windows 10, Version 3.1

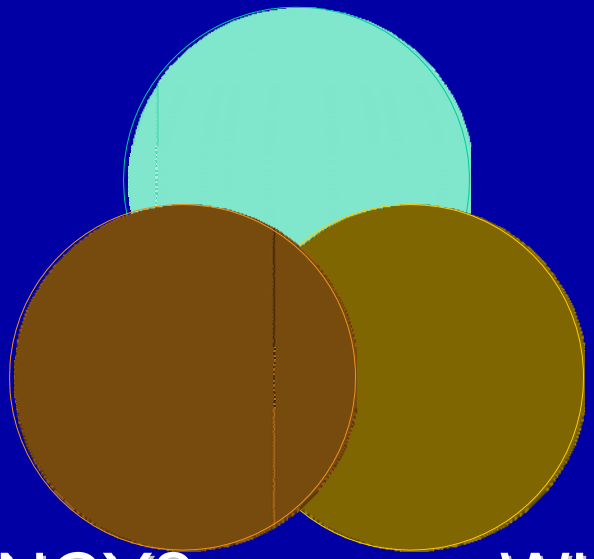
http://www.spacew.com/www/fof2.html



See also: http://www.sws.bom.gov.au/Images/HF%20Systems/Global%20HF/Ionospheric%20Map/WorldIMap.gif

LinkEstablishment

WHAT TIME?



WHAT FREQUENCY?

WHAT MODE?

What Time?

Establish *written* time protocols!

As an example from Blaine Osepchuk, VE6BKO from Edmonton ARES:

“Use 1.844 MHz (LSB) for night time NVIS from 2 hours after dark until 2 hours after sunrise”

What Mode?

- Establish *written* Mode Protocols!
- Example from VE6BKO:

"1.844 MHz (LSB)"

"3.765 MHz (LSB)"

"7.055* MHz (LSB)"

(*in Canada)

What Frequencies?

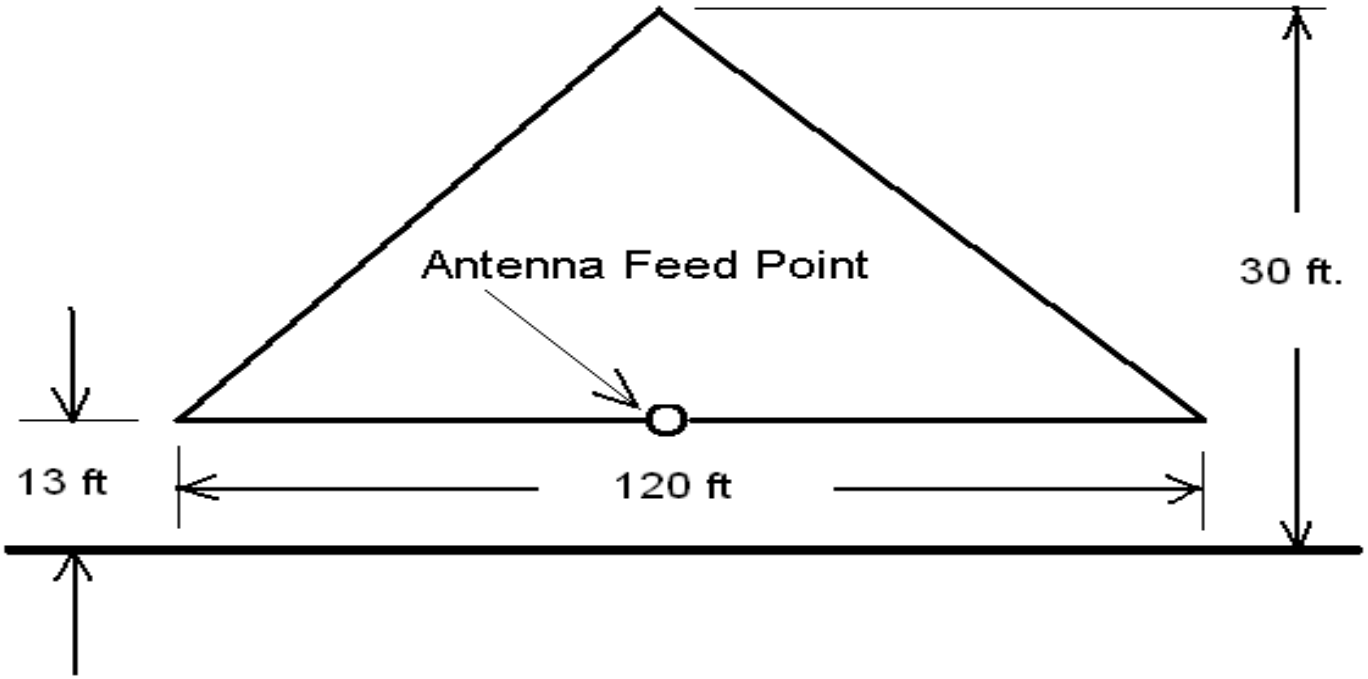
Establish *written* Frequency Protocols!

- “Use the highest frequency for the link”
- “Freq. busy? Move up 3 kHz, and call or listen for 2 minutes”
- “Busy or nothing heard? Move up 3 kHz and call or listen for 2 minutes”
- “Still nothing heard? Return to original frequency, and start over”
- “Do not continue to move up the ban”

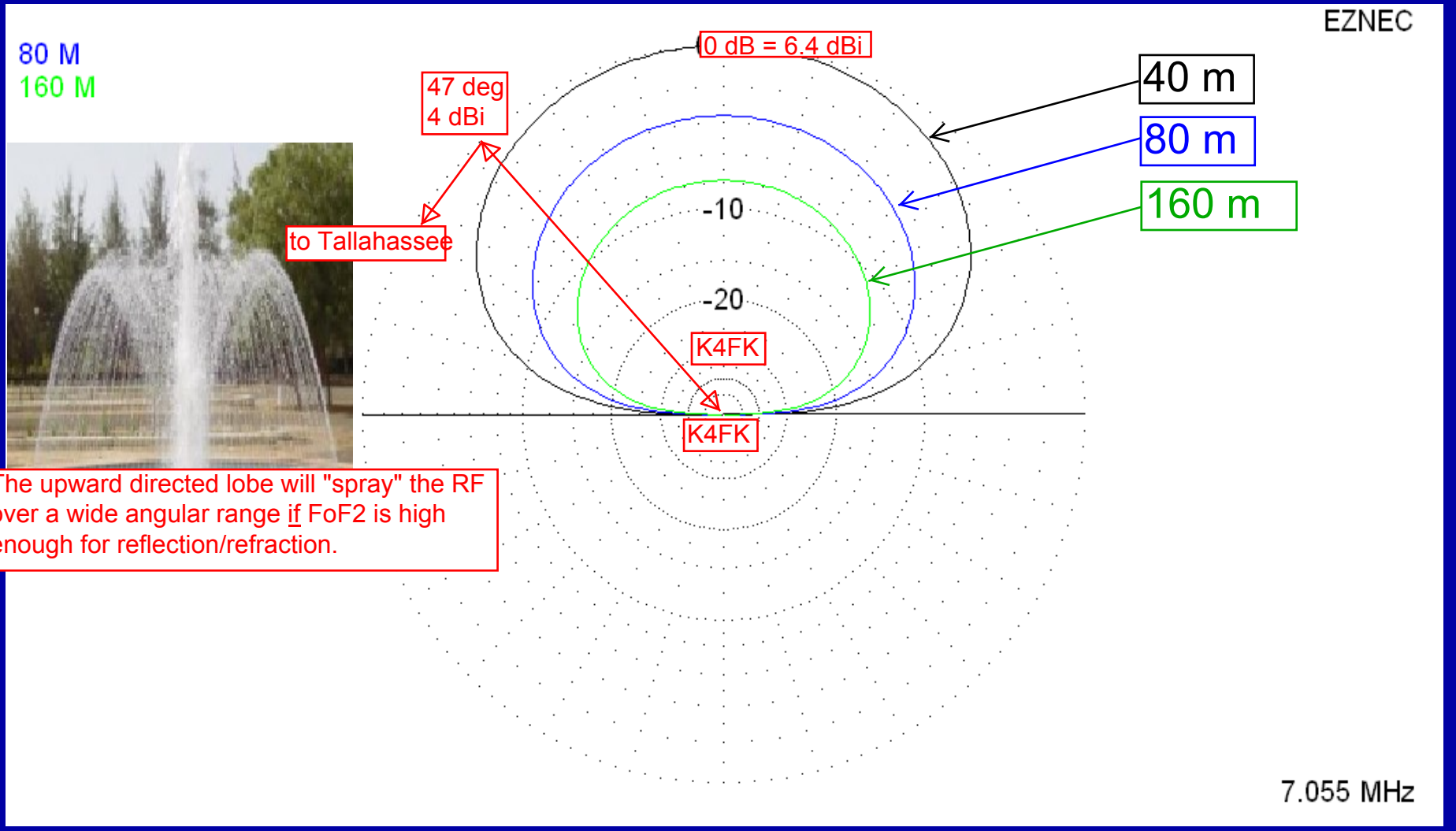
NVIS Antennas

- ARES ops will need simple Dipoles or Inverted Vs, or Vertical Loops
- Base stations can use more “real estate” to add 3 to 6 dB by using a gain antenna
- We need an antenna that works well over the 160 m, 80 m, 60 m and 40 m bands
- Usually, this means 3 - 4 antennas fed from a common transmission line.

Marc Tarplee, Ph.D, N4UFP
3-Band NVIS Vertical Loop

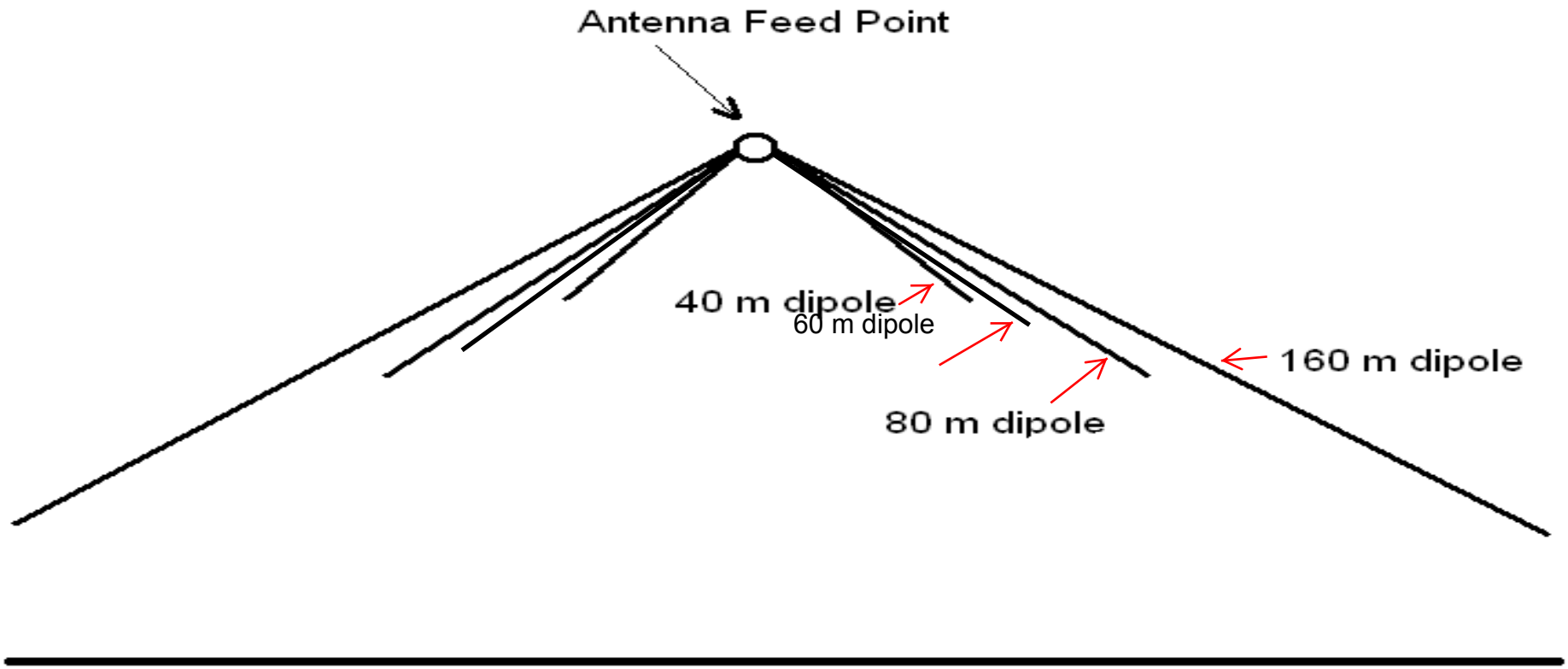


Tarplee NVIS Loop Elevation Plots



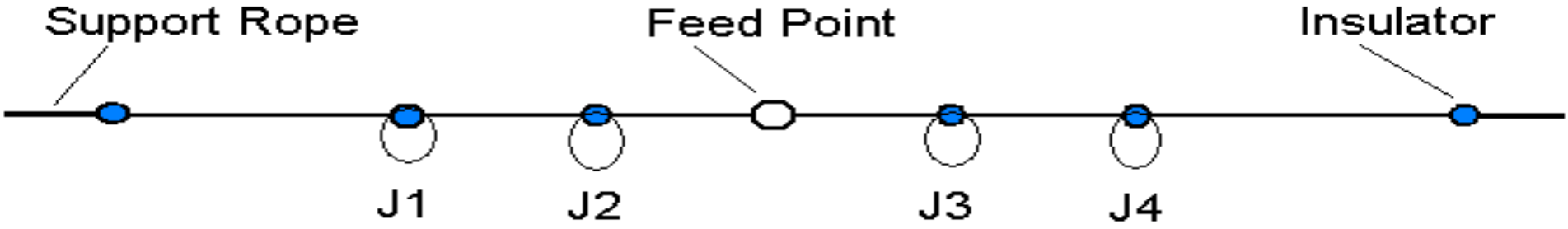
The upward directed lobe will "spray" the RF over a wide angular range if FoF2 is high enough for reflection/refraction.

NVIS 4-dipole Inverted V



3-Band “Jumpered” Dipole

40m: no jumpers.
80m: jumpers J2 and J3, only.
160m: jumpers J1, J2, J3, J4



Advantages: Full-size dipoles on each of the 3 bands.
Resonant lengths allow easy SWR Matching.

Disadvantages: The antenna must be lowered to change frequencies.
No rapid QSY allowed.

Getting your feet wet with NVIS

- Experiment on 80 m with a low horizontal dipole or inverted V; apex at 25 to 40 feet
- Get a list of the nearby (Provincial or State) 80 m nets to your QTH, and listen to the check-ins; Observe the wide area coverage
- Check the internet for the hourly FoF2, and become more “propagation savvy”

NVIS "Re-Cap"

- NVIS is a *Technique*…(*not an antenna!*)
- Equipment and power levels are straight forward and usual for HF Operation
- The unique things about NVIS are the low horizontally polarized antennas, and the need to operate close to the F2 Critical Frequency
- NVIS techniques could be the "Silver Bullet" for ARES HF Operation

References

SkyTrig: R.J. Edwards, G4FGQ, (SK): http://www.wireless.org.uk/g4fgq/page3.html

Solar Terrestrial Activity Report: http://www.dxlc.com/solar/

Australian Government: Ionospheric Prediction Service: HAP Charts: IPS Radio & Space Services
http://www.ips.au/hf_systems/4/1

ARES Edmonton AB: Blaine Osepchuk, VE6BKO
http://members.shaw.ca/ve6bko/overview.html
http://members.shaw.ca/ve6bko/update01.html

Dr. Marc C. Tarplee, Ph.D., N4UFP: Near Vertical Incidence Skywave (NVIS).ppt
http://www.arrl-sc.org/tech_presentations_by_n4ufp_tc.htm

EZNEC: Antenna Software by W7EL, Roy Lewallen, P.E., W7EL
http://www.eznec.com

HamCap 1.5 Alex Shovkoplyas, VE3NEA
http://www.dxatlas.com/hamcap/

RAC/TCA Amateur Radio Calculators: Professor Emeritus David Conn, Ph.D., P.Eng., VE3KL
"Field Strength" and " Received Power and Path Loss"
http://www.rac.ca/tca/tcacalculators.htm

More References

SkyTrig.exe	**http://wireless.org.uk/g4fgq/skytrig.exe** can be run on Win 8.1-10 in DOSBox: **https://www.dosbox.com/**
Proplab for Win 10:	**http://shop.spacew.com**
DXAtlas:	**http://www.dxatlas.com/**
4nec2:	Arie Voors, NEC based antenna modeler and optimizer, **www.qsl.net/4nec2/**

NVIS with an ARES Slant

Thank you, Questions???

73, and Thanks to Rick Lord, P.Eng, VE4O, for his source material