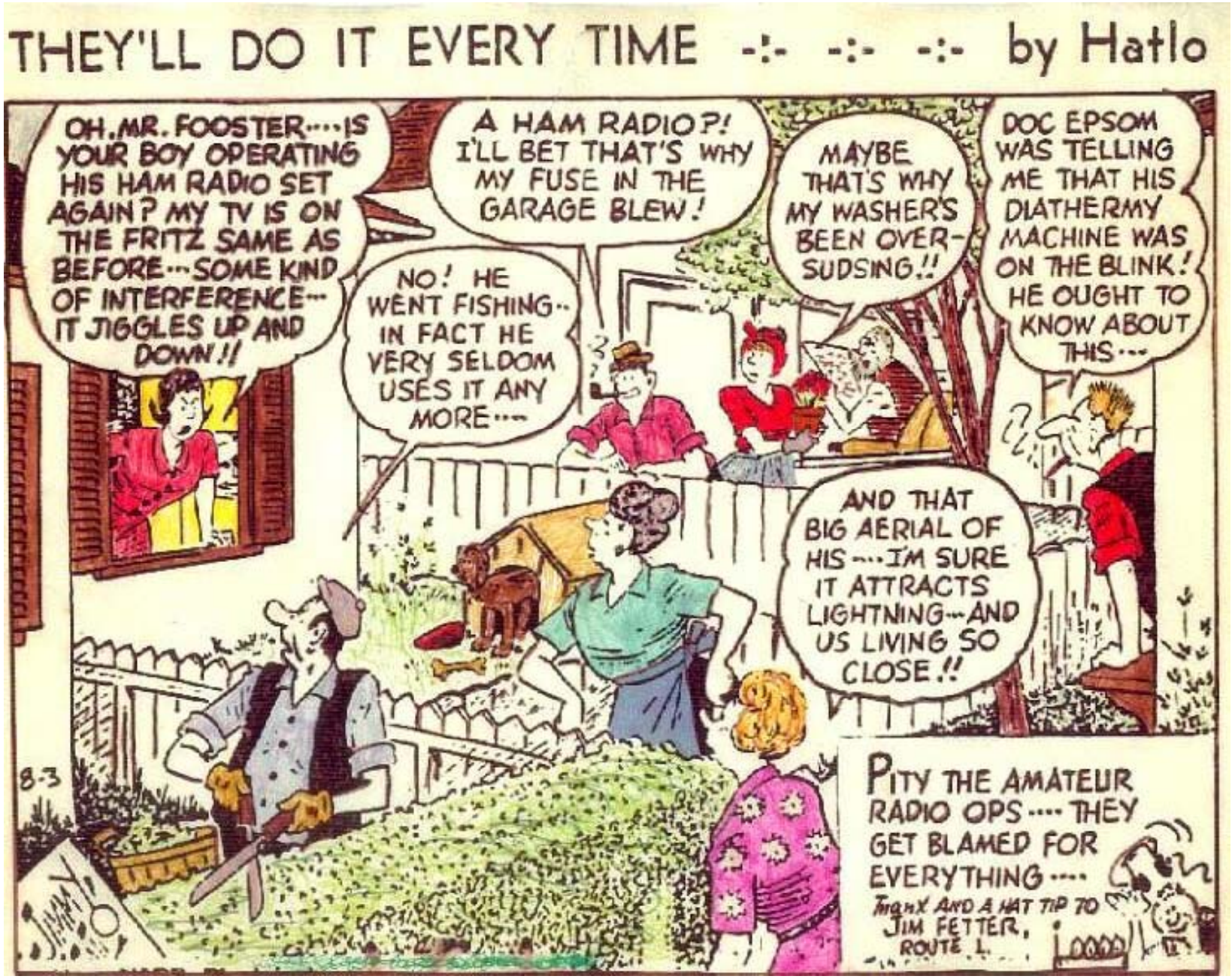


Newspaper cartoon from the early 60's

NVIS for Emergency Communications

Ross Mazzola
Monroe County (NY) ARES

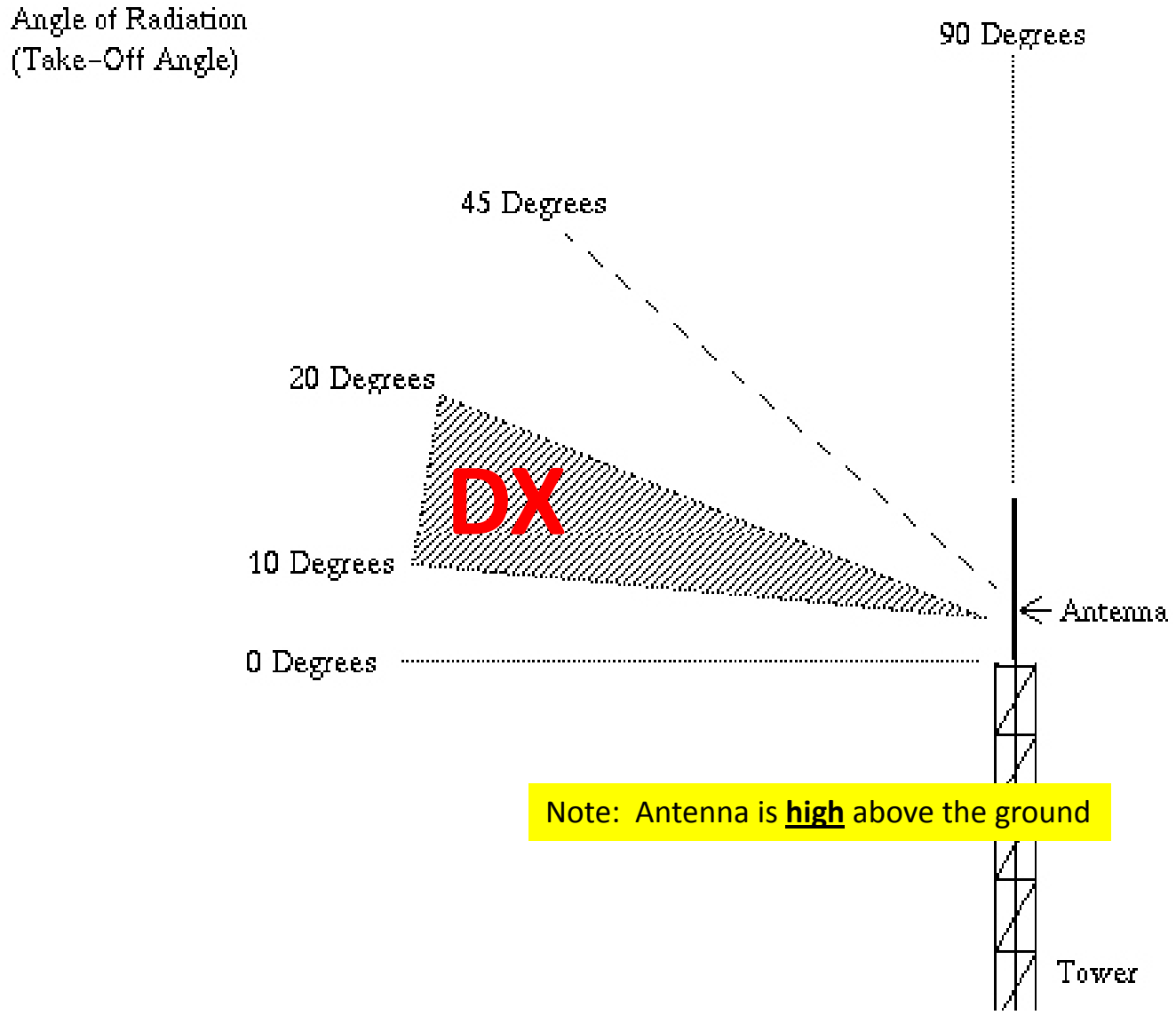
Why NVIS?

Damage to Infrastructure


Difficult Terrain
Valleys
Canyons
Mountains
Forests
Jungles

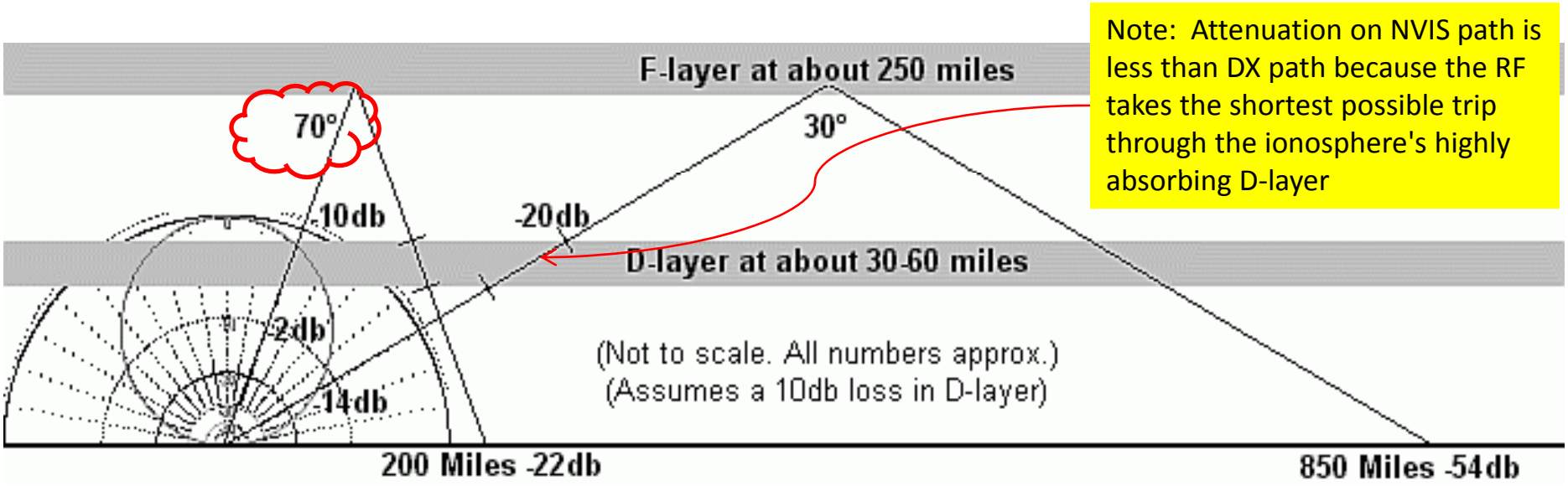
What is NVIS?

Low Angle of Radiation



Note: Antenna is **high** above the ground

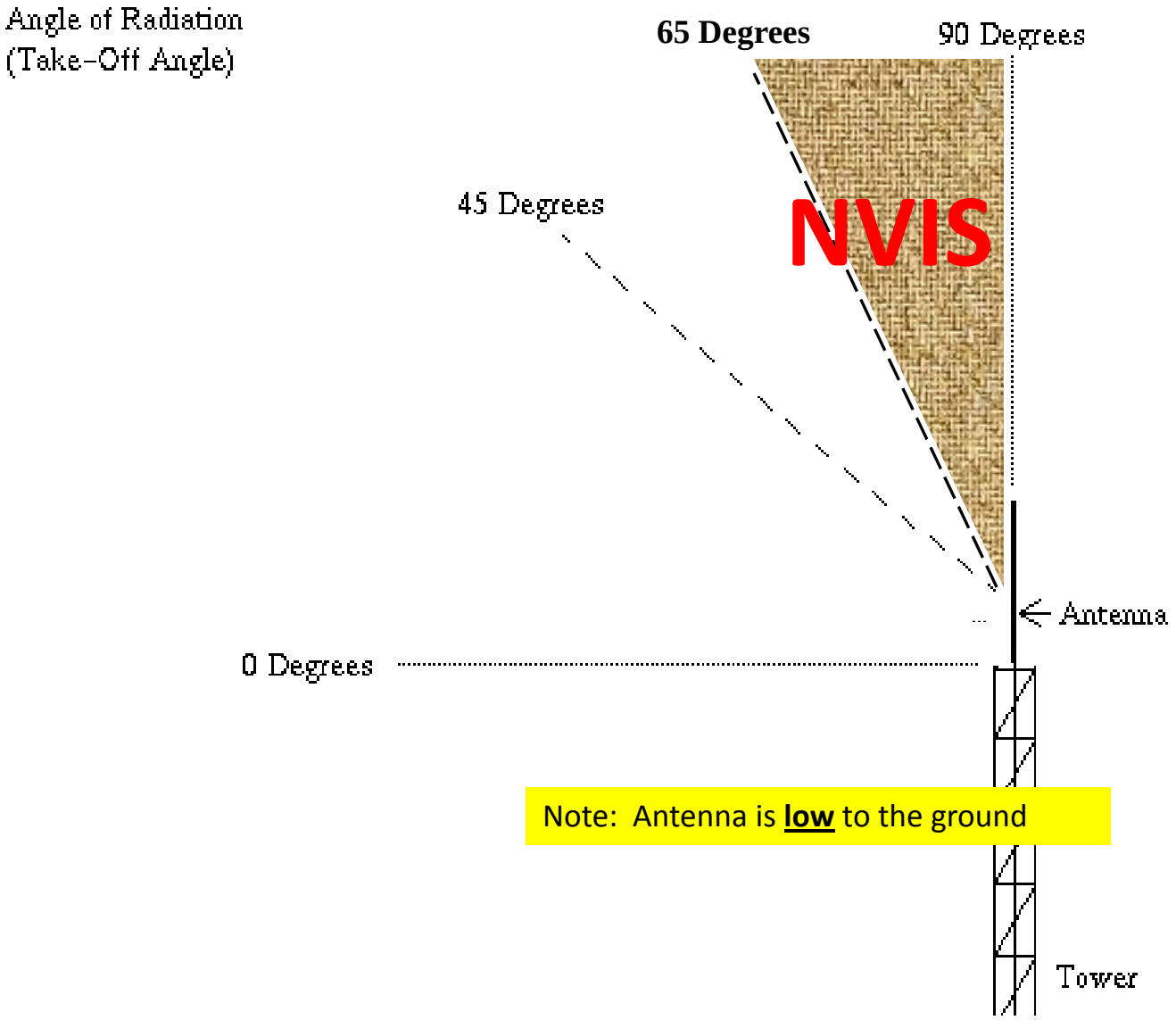
NVIS Definition



Note: Attenuation on NVIS path is less than DX path because the RF takes the shortest possible trip through the ionosphere's highly absorbing D-layer

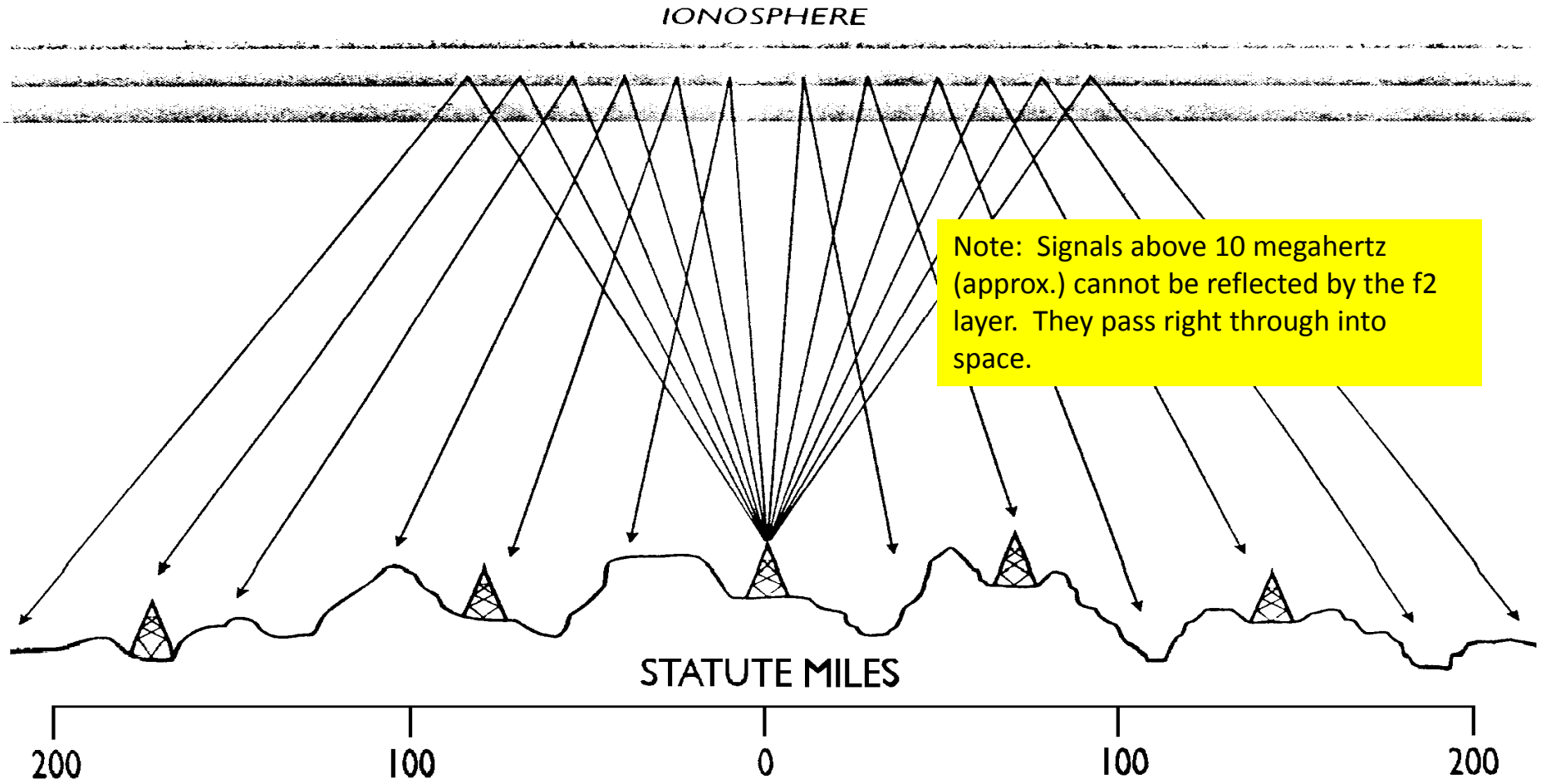
Near-Vertical Incident Skywave ("NVIS") is a mode of radio propagation using F-Layer atmospheric refraction around 65° to 90° (near vertical)

High Angle of Radiation



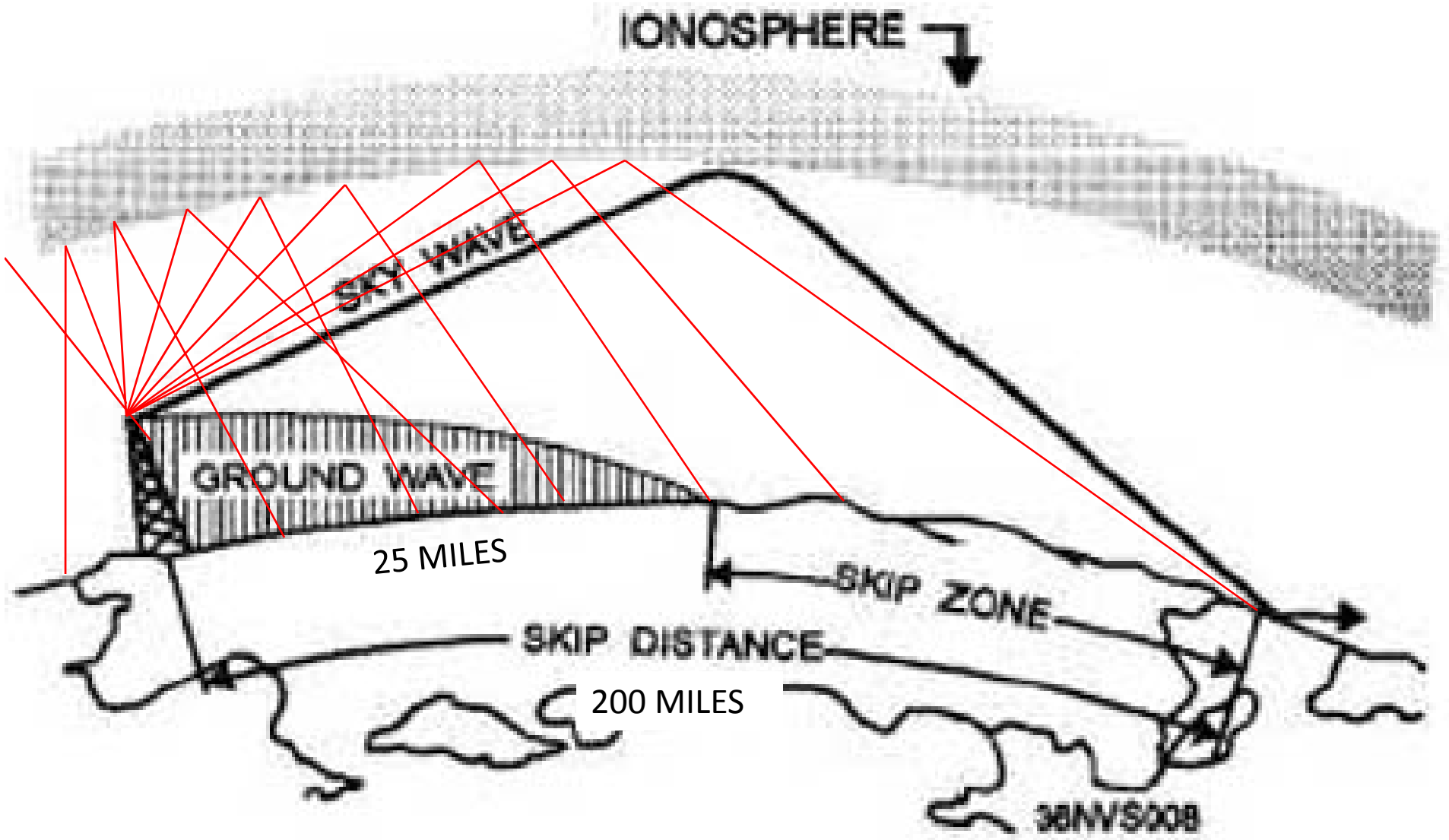
Note: Antenna is **low** to the ground

300-400 mile Coverage is Typical

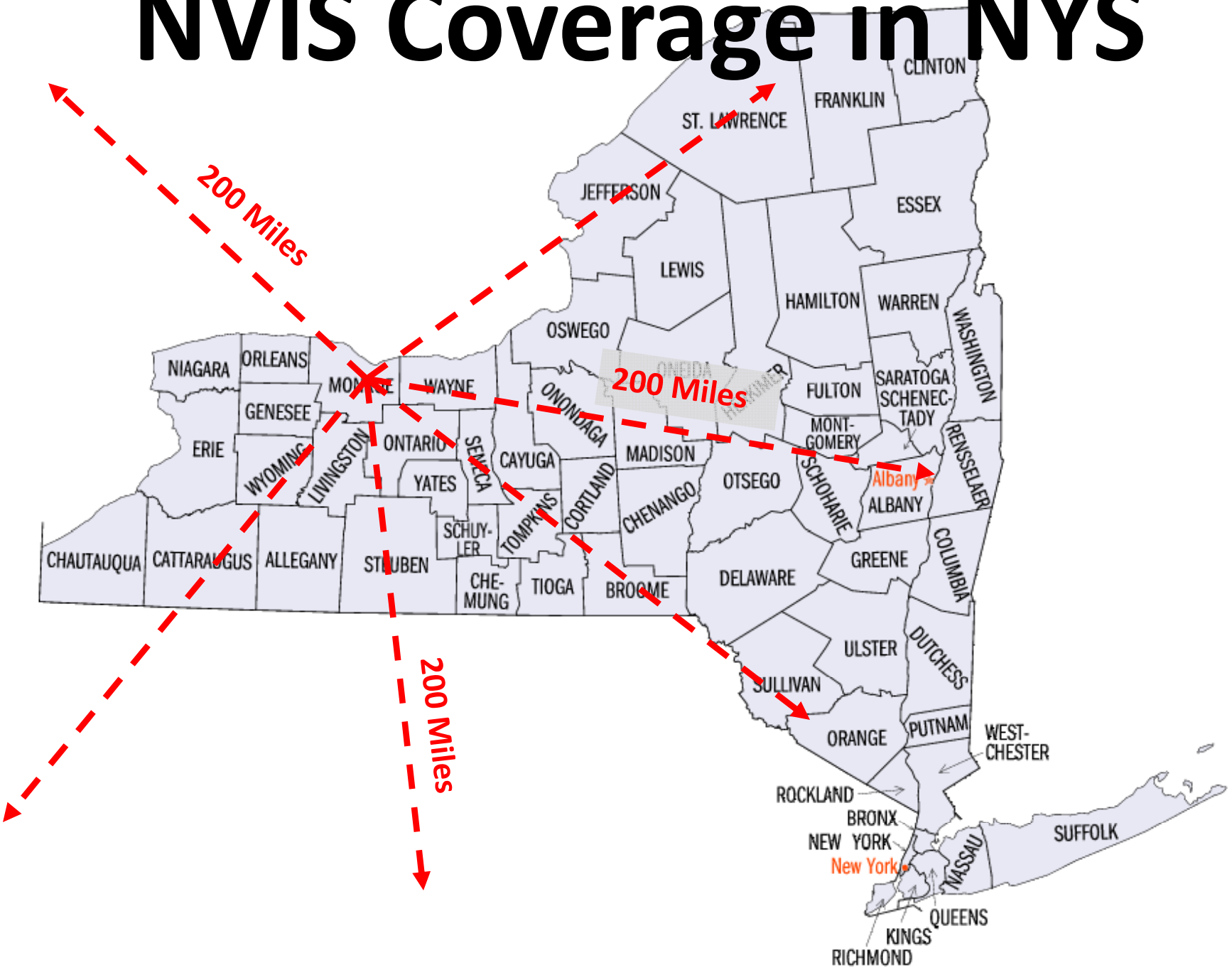


Note: Signals above 10 megahertz (approx.) cannot be reflected by the f2 layer. They pass right through into space.

NVIS Covers the Skip Zone



NVIS Coverage in NYS



History of NVIS

- Pioneered by the Germans in WWII
- Known as "rail" or "cage" antenna
- Widely used by the US forces in Vietnam
- Still in use for communications in rough mountainous terrain

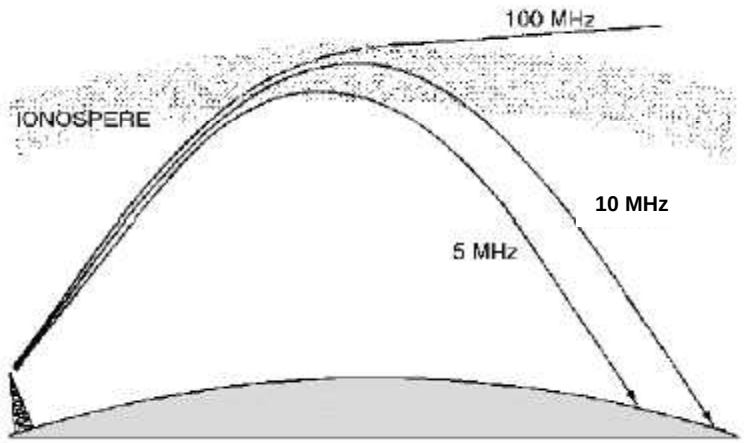
NVIS is a System

- License to operate on HF
  - Low-Band Frequencies, typically 40m and 80m
- Equipment
  - HF Radio (100W is sufficient)
  - Tuner (only if necessary)
- Emergency Power
  - Battery
  - Generator
  - Charging
- Frequency
  - Correct Frequencies are Used
  - Frequency Coordination Plan
- Antenna
  - Direct RF upwards (“cloudwarmers”)

What Frequencies Should I Use?

Critical Frequency

- The highest frequency which the ionosphere will reflect vertically is called foF2
- In order for NVIS signals to be returned to the earth's surface, its frequency must be less than the critical frequency of the F-layer
- During daylight, the critical frequency is approx 5 to 10 MHz. After Sunset, the critical frequency drops throughout the night reaching a low of 2 to 5 MHz just before dawn

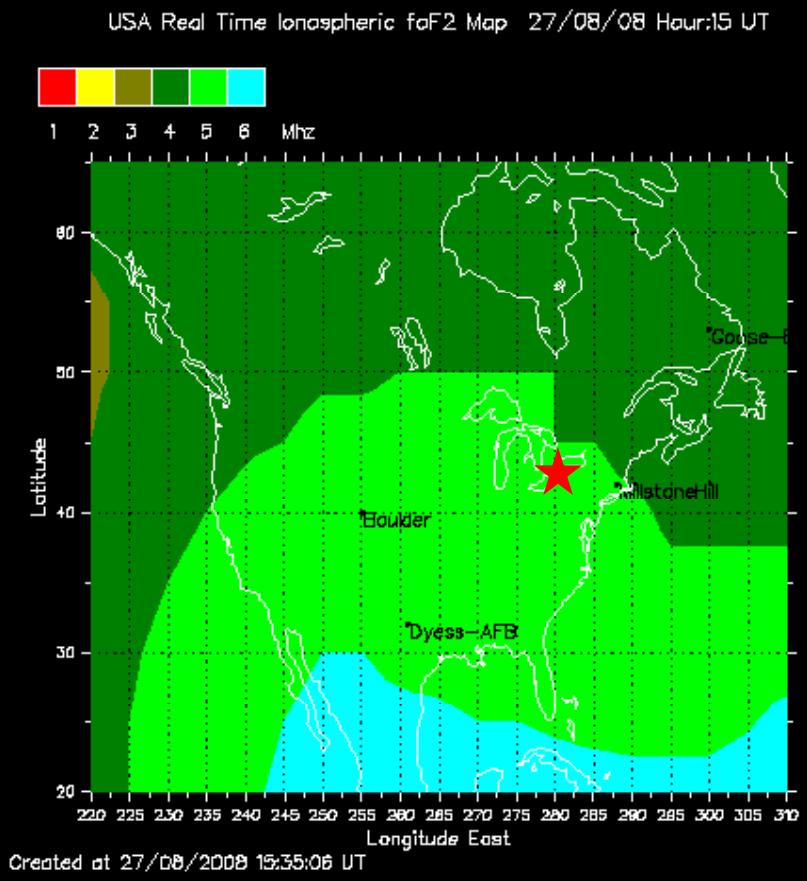


Critical Frequency

These foF2 measurements from various sites are used to create a map of foF2. The maps below can be used as a guide to NVIS ionospheric frequency support.

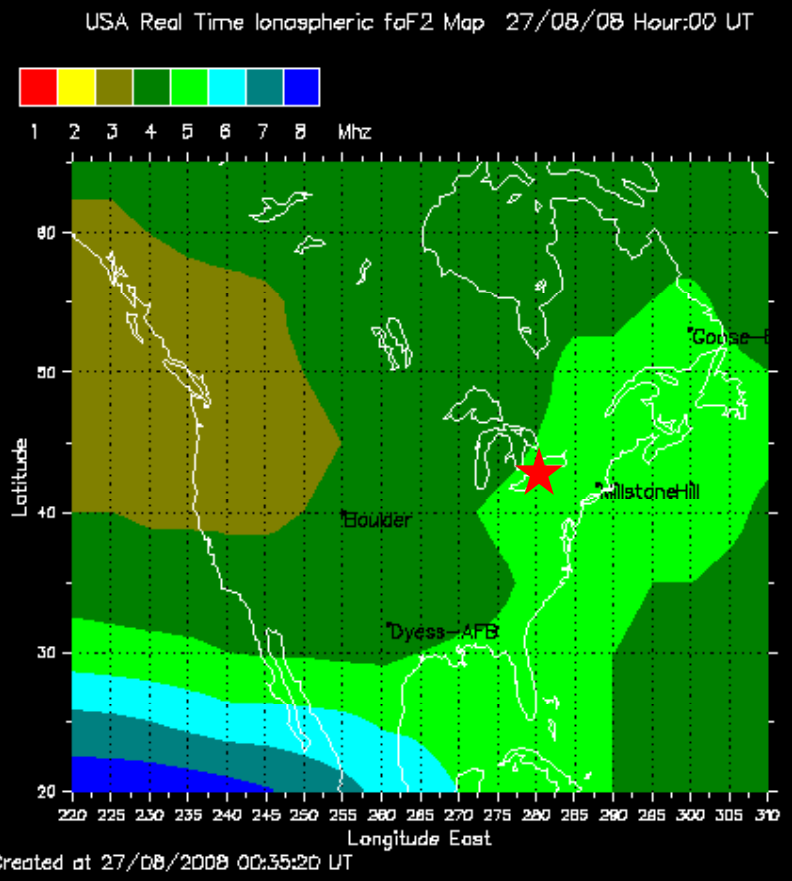
Day

(12 noon local)



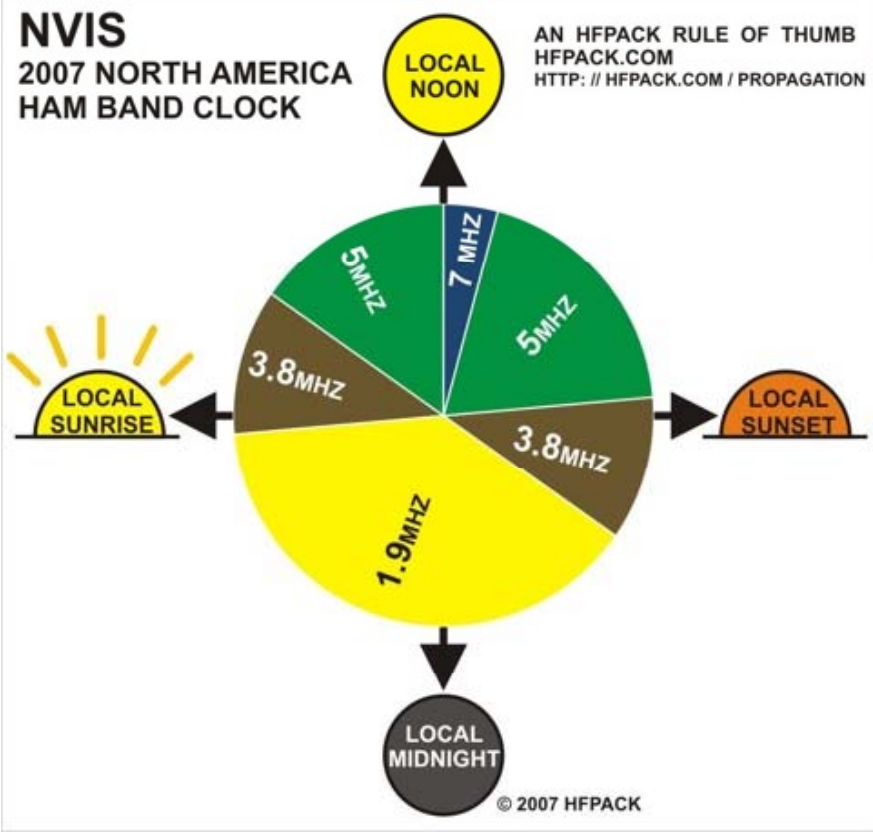
Night

(9 pm local)



Frequency Selection

- General opinion is that NVIS technique works from roughly 2 to 10 MHz
- Time of day, time of year, sunspot activity, type of antenna used, atmospheric noise, and atmospheric absorption affect the frequency selection
- High sunspot activity- 60, 40, 30 m best daytime bands; 80 m night
- Low sunspot activity- 80, 60, 40 best daytime bands; 80 or 160 m night



Frequency Selection

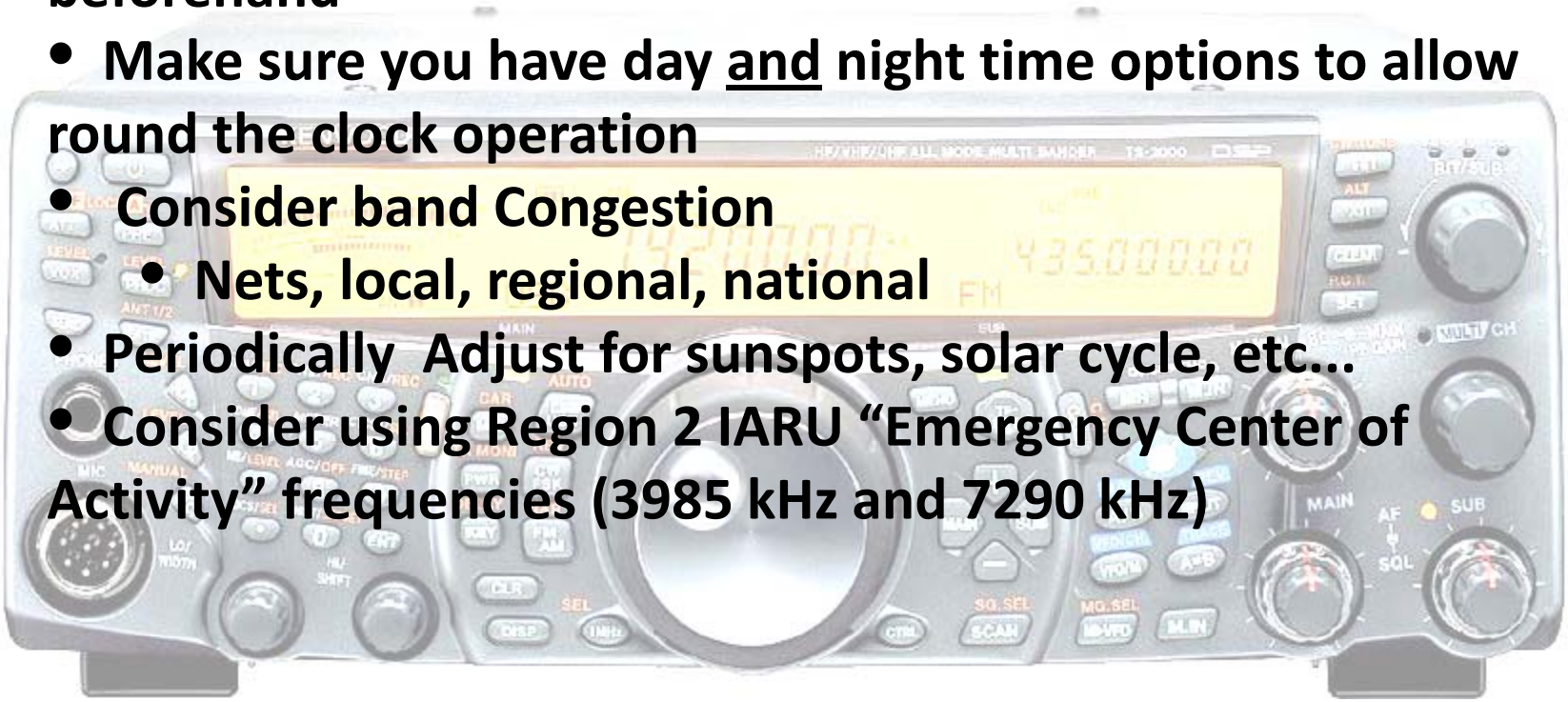
- The Critical Frequency is the key to successful NVIS working
- A good “working” frequency for NVIS will often be between

10 - 15% below, i.e. 85% of the FoF2 Critical Frequency

10% below foF2 Critical Frequency	15% below foF2 Critical Frequency	foF2 Critical Frequency (Mhz) from USA Map	Closest Amateur Band Working NVIS frequency (Mhz)
0.9	0.9	1	
1.7	1.8	2	1.8 - 2.0
2.6	2.7	3	
3.4	3.6	4	3.8 - 3.9
4.3	4.5	5	4.0
5.1	5.4	6	
6.0	6.3	7	
6.8	7.2	8	7.1 - 7.3

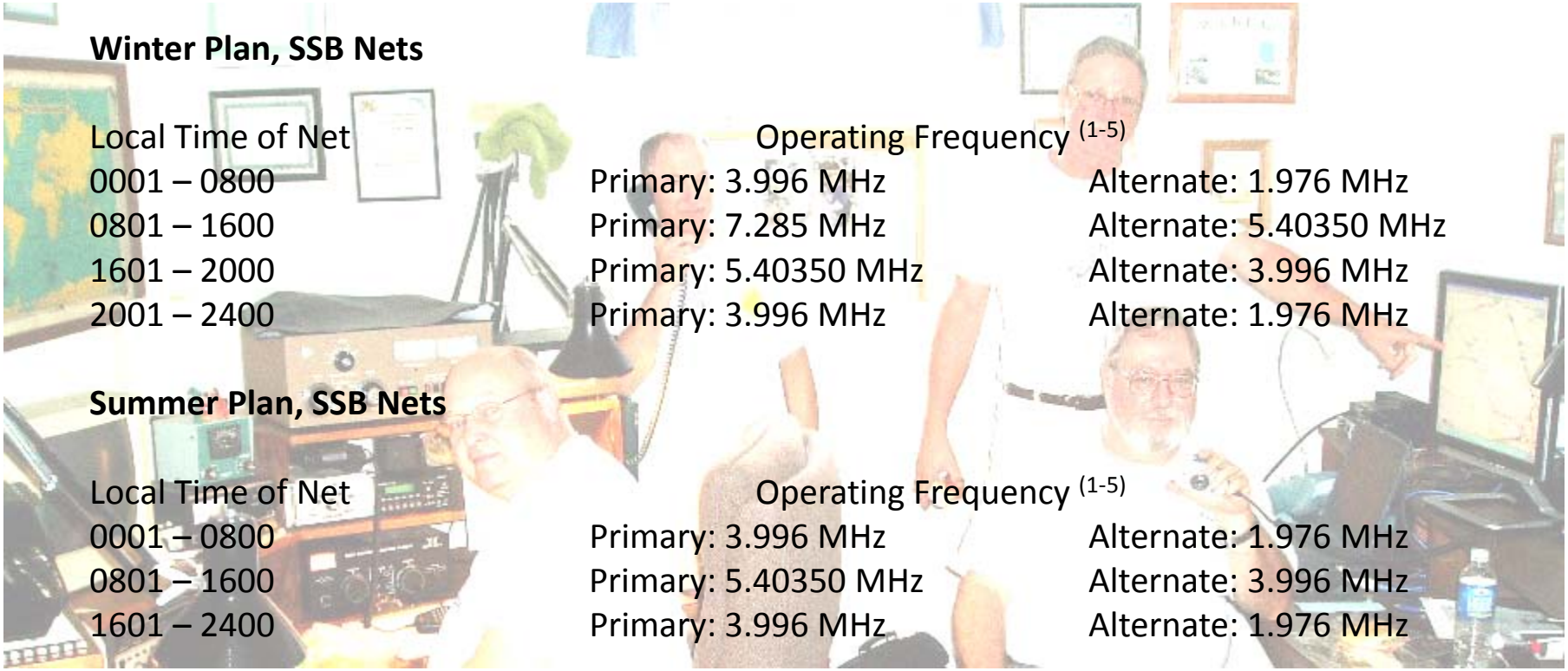
Frequency Planning

- Net must be prepared to change frequency as conditions change
- Procedures for frequency hopping should be agreed on beforehand
- Make sure you have day and night time options to allow round the clock operation
- Consider band Congestion
  - Nets, local, regional, national
- Periodically Adjust for sunspots, solar cycle, etc...
- Consider using Region 2 IARU “Emergency Center of Activity” frequencies (3985 kHz and 7290 kHz)



NVIS Plan Example

Courtesy of Marc Tarplee, N4UFP



Winter Plan, SSB Nets

Local Time of Net	Operating Frequency (1-5)	
0001 – 0800	Primary: 3.996 MHz	Alternate: 1.976 MHz
0801 – 1600	Primary: 7.285 MHz	Alternate: 5.40350 MHz
1601 – 2000	Primary: 5.40350 MHz	Alternate: 3.996 MHz
2001 – 2400	Primary: 3.996 MHz	Alternate: 1.976 MHz

Summer Plan, SSB Nets

Local Time of Net	Operating Frequency (1-5)	
0001 – 0800	Primary: 3.996 MHz	Alternate: 1.976 MHz
0801 – 1600	Primary: 5.40350 MHz	Alternate: 3.996 MHz
1601 – 2400	Primary: 3.996 MHz	Alternate: 1.976 MHz

Notes:

(1) If primary frequency cannot support NVIS, the net will move to the alternate frequency for the time period in which the net is operating. If the alternate frequency cannot support NVIS, the net will move to the alternate frequency of the next later time period, if it is lower than the current alternate frequency. If the alternate frequency of the later time period is not lower, use the alternate frequency from the adjacent earlier time period, if it is lower. If a lower alternate frequency cannot be found, the net must be moved to VHF.

(2) Band changes will occur at quarter hour intervals.

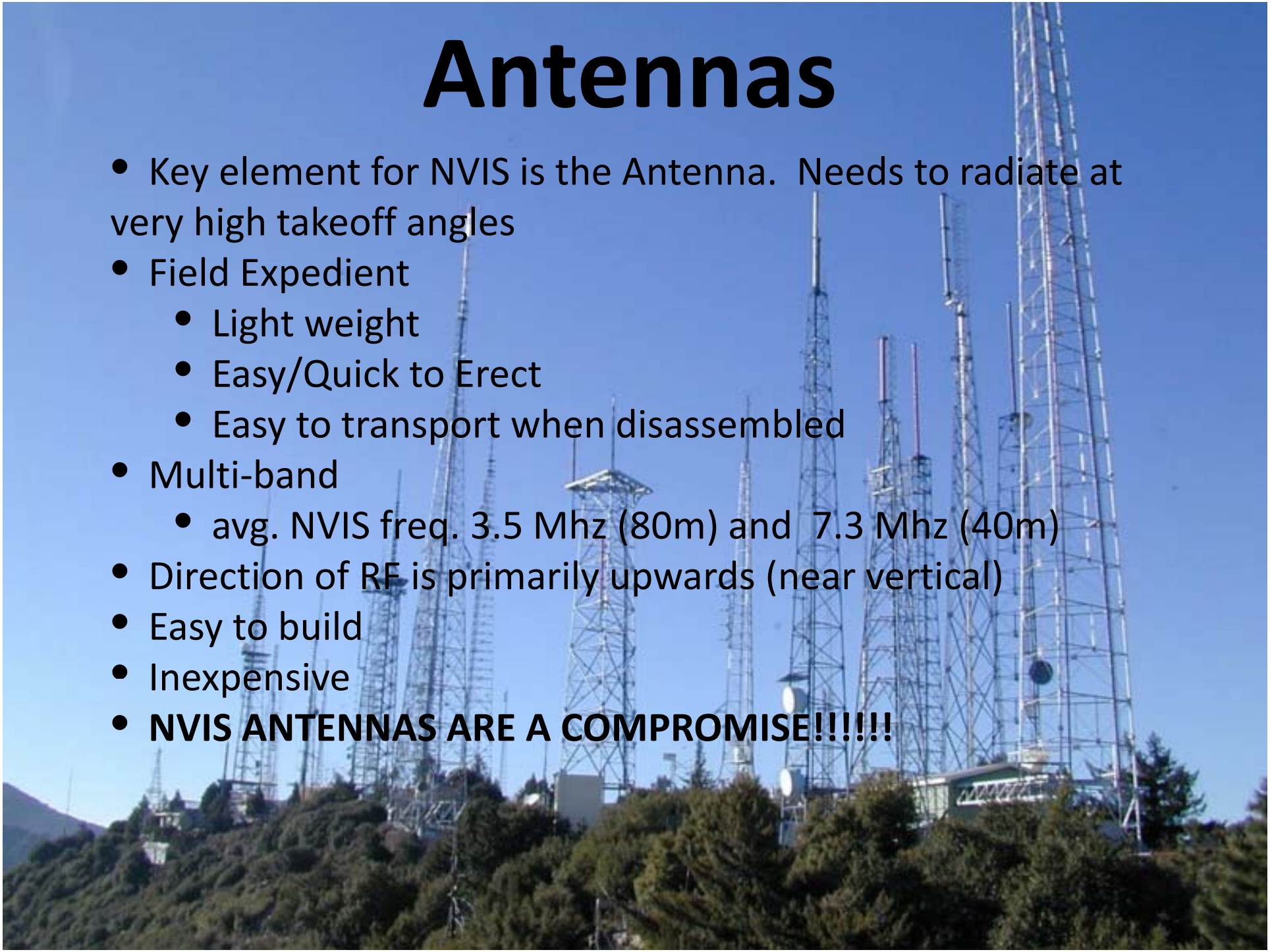
(3) All operating frequencies, other than those in the 60m band, may vary by +/- 10 KHz to avoid interference.

(4) Output power on 60m must be limited to 50 W PEP.

(5) Only USB is allowed on 60 m

What Antenna Should I Use?

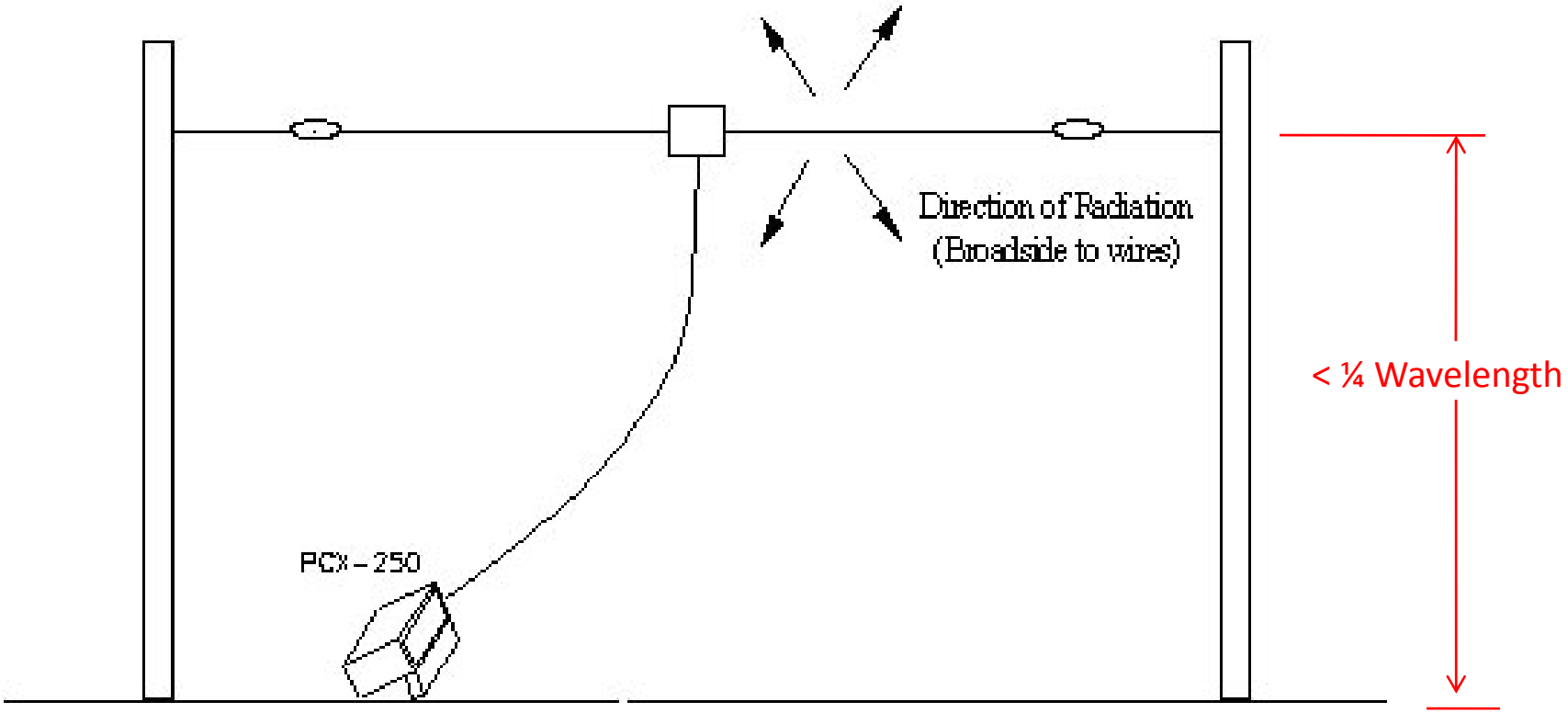
Antennas



- Key element for NVIS is the Antenna. Needs to radiate at very high takeoff angles
- Field Expedient
  - Light weight
  - Easy/Quick to Erect
  - Easy to transport when disassembled
- Multi-band
  - avg. NVIS freq. 3.5 Mhz (80m) and 7.3 Mhz (40m)
- Direction of RF is primarily upwards (near vertical)
- Easy to build
- Inexpensive
- **NVIS ANTENNAS ARE A COMPROMISE!!!!!!**

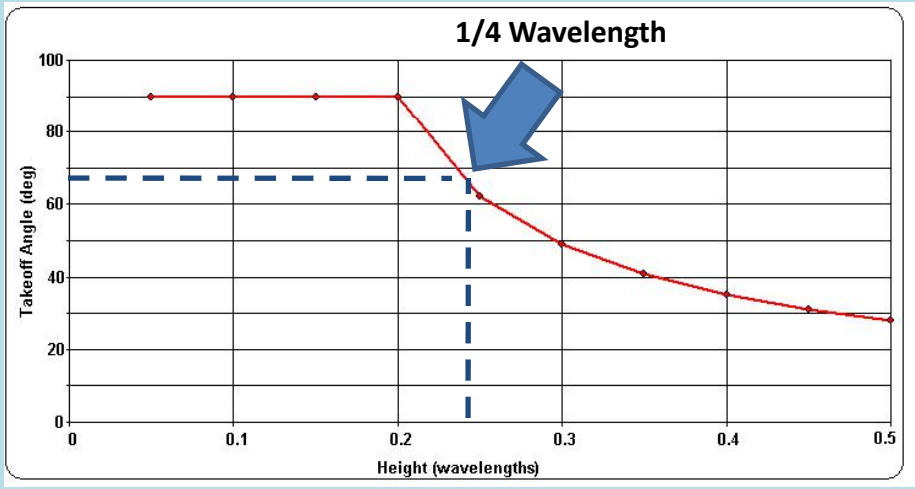
Are You NVIS Now?

- **Horizontal antennas mounted less than ¼ wavelength above ground have maximum radiation at high angles!**



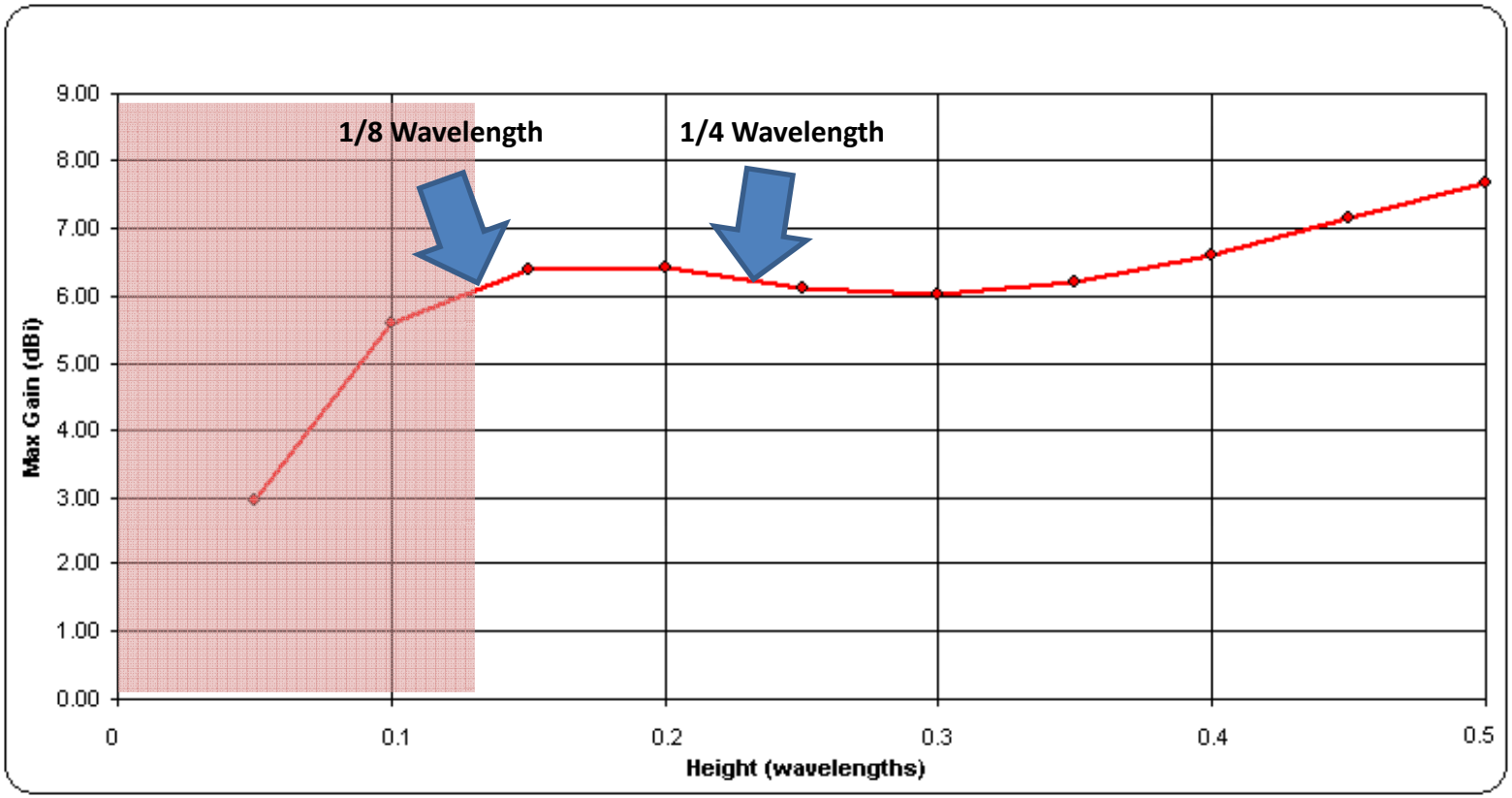
Height Above Ground

- **Single most controversial subject!**
- Height Above Ground
  - Below ¼ wave recommended
  - Some have found 10’ – 15’ height functions very well
  - Some tests show NVIS efficiency is best at ten to 15 foot height for 40m to 75m frequency range
  - Lowering the antenna to near 1/20th wavelength lowers the background noise level



Gain

- As horizontal dipole moves closer to the earth, the gain begins to decrease because the ground is lossy

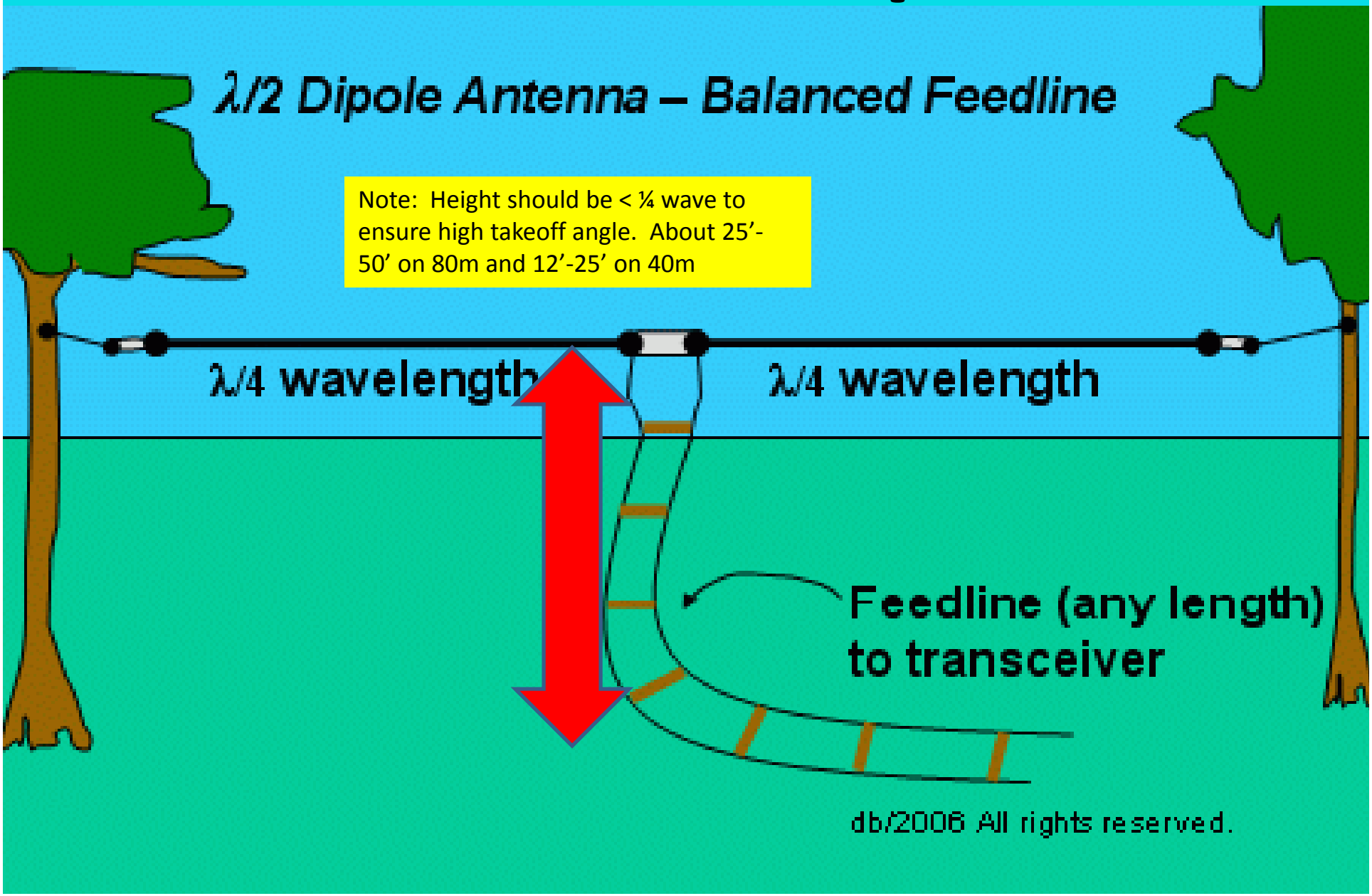


NVIS Antennas That Work

- Loop Antenna
  - Two Wavelength Loop
  - Full Wavelength Loop

  } **Very effective, but not practical**
- Half wavelength Horizontal Dipole
  - Low Dipole
  - Fan Dipole
- Inverted V
- Random Wire
- “Dual Ham-stick” short dipole

Horizontal Dipole

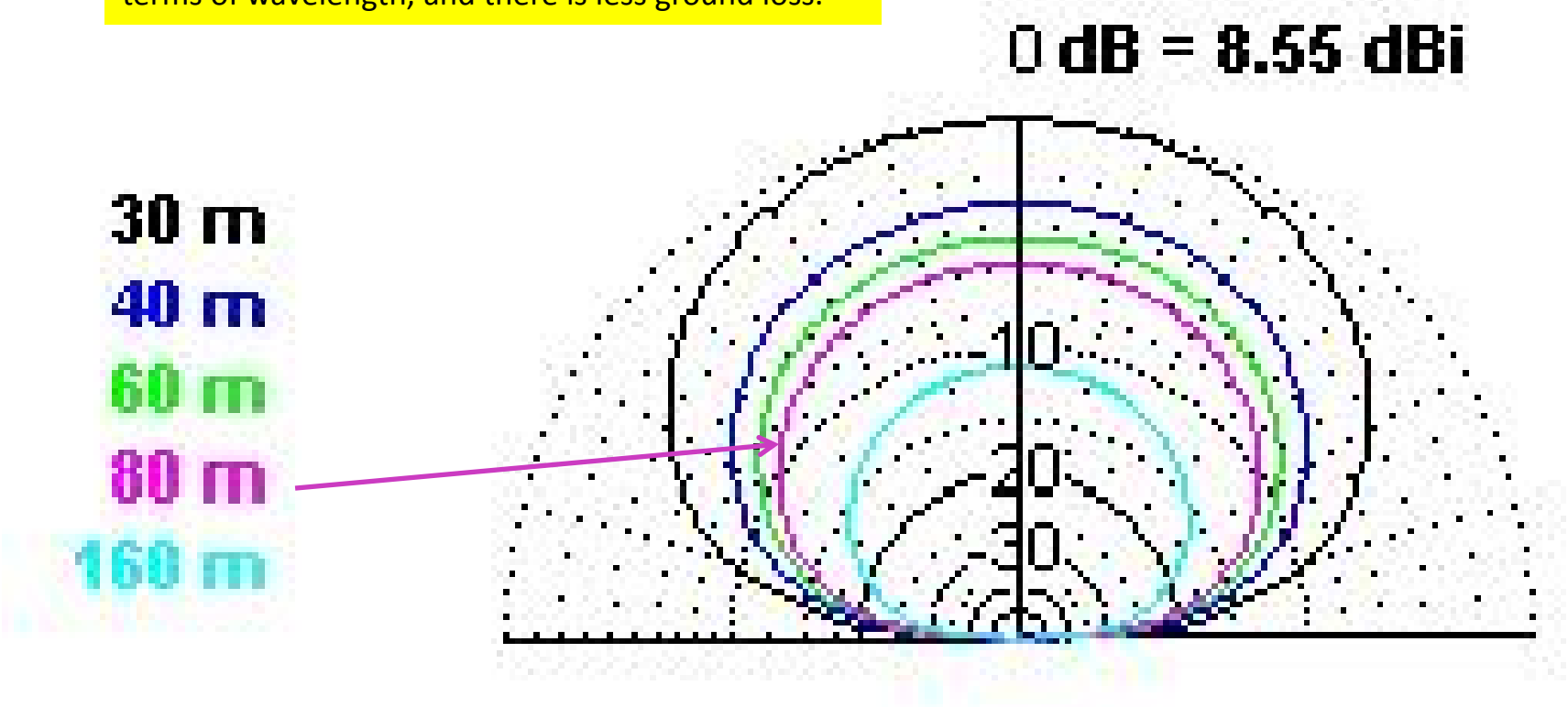


Low Dipole

- Two supports
- Low = 1’ to 6’
- Some designs use reflector wires

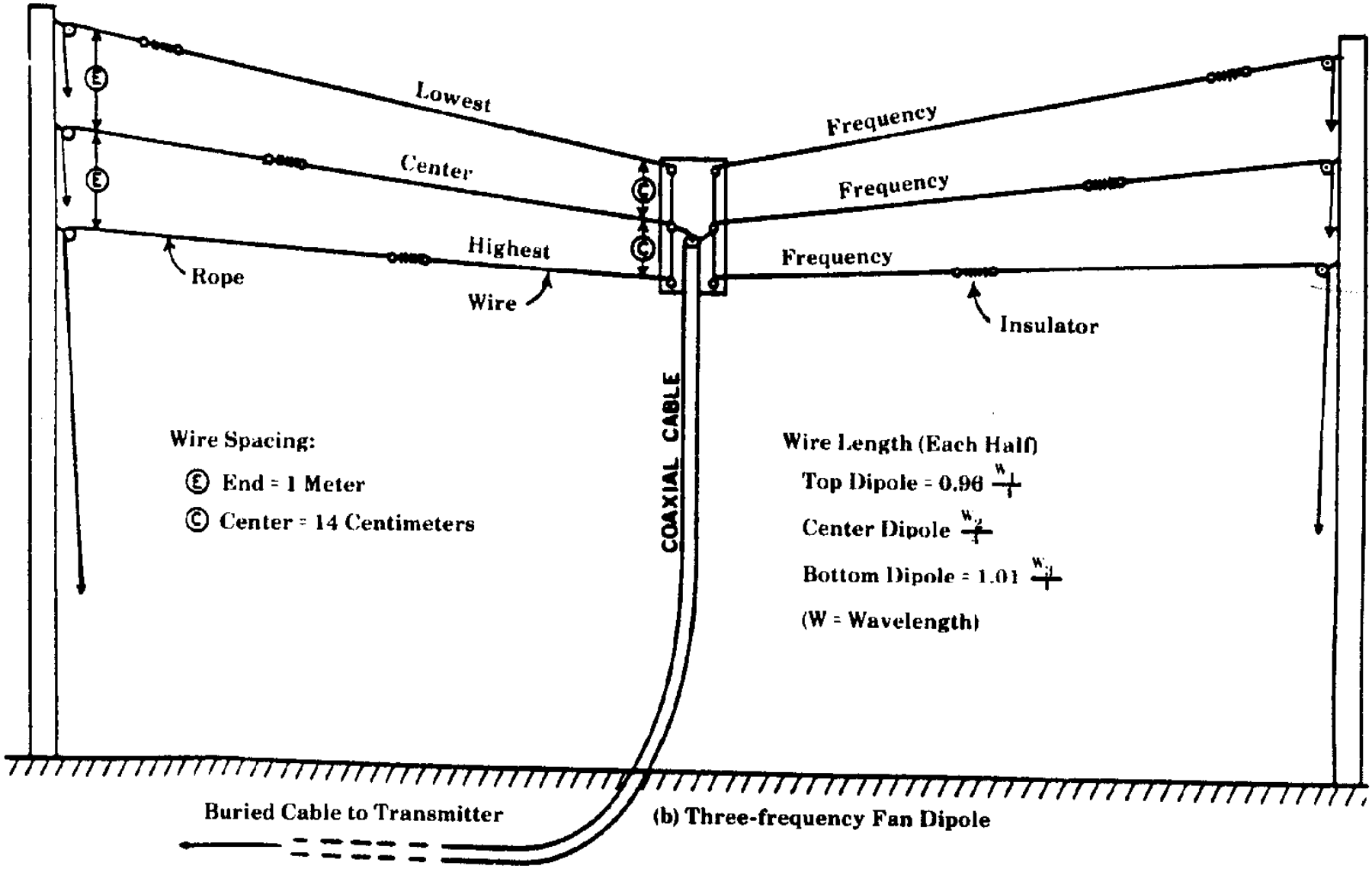
Low Dipole

Note: The shape of the elevation pattern doesn't change much as the frequency is varied over a 5 to 1 range. The gain increases at higher frequencies because the antenna is farther from the ground, in terms of wavelength, and there is less ground loss.



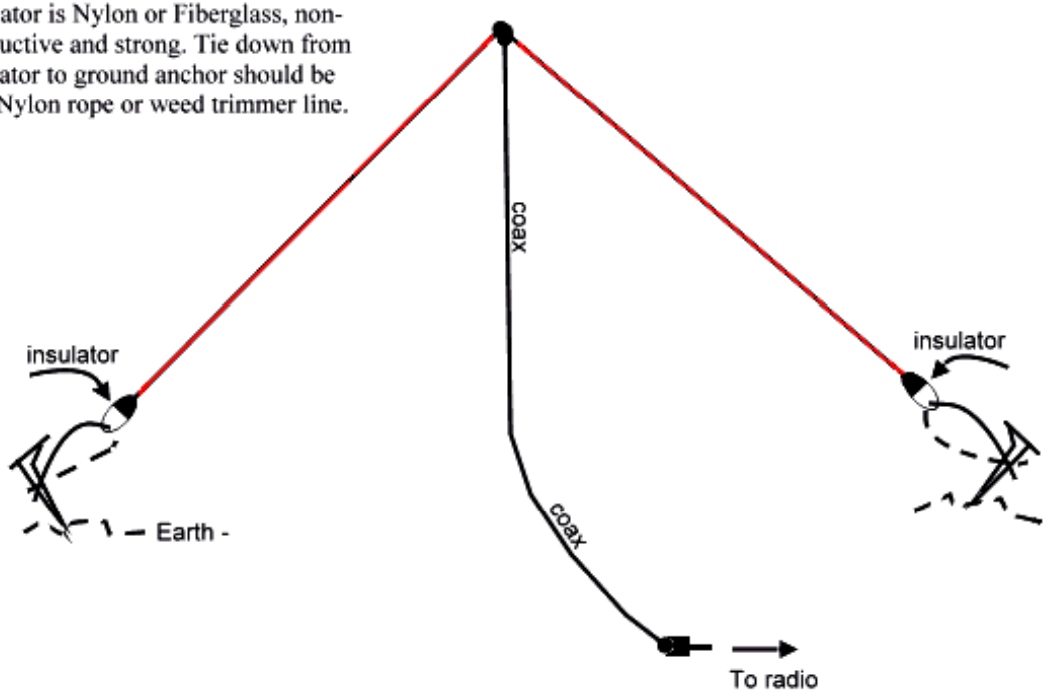
Elevation Radiation pattern of an 80m NVIS dipole 12.5 ft above ground

Fan Dipole


Lowest
Frequency
Center
Frequency
Highest
Frequency
Rope
Wire
Insulator
COAXIAL CABLE
Wire Spacing:
E End = 1 Meter
C Center = 14 Centimeters
Wire Length (Each Half)
Top Dipole = 0.96 W/2
Center Dipole W/2
Bottom Dipole = 1.01 W/2
(W = Wavelength)
Buried Cable to Transmitter
(b) Three-frequency Fan Dipole

Inverted V

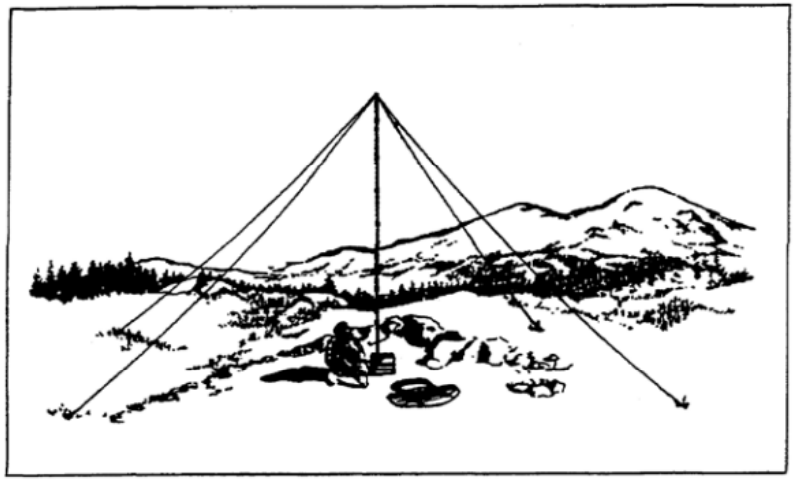
Coax is 50 ohm, such as RG-58 or RG-8. Insulator is Nylon or Fiberglass, non-conductive and strong. Tie down from insulator to ground anchor should be thin Nylon rope or weed trimmer line.



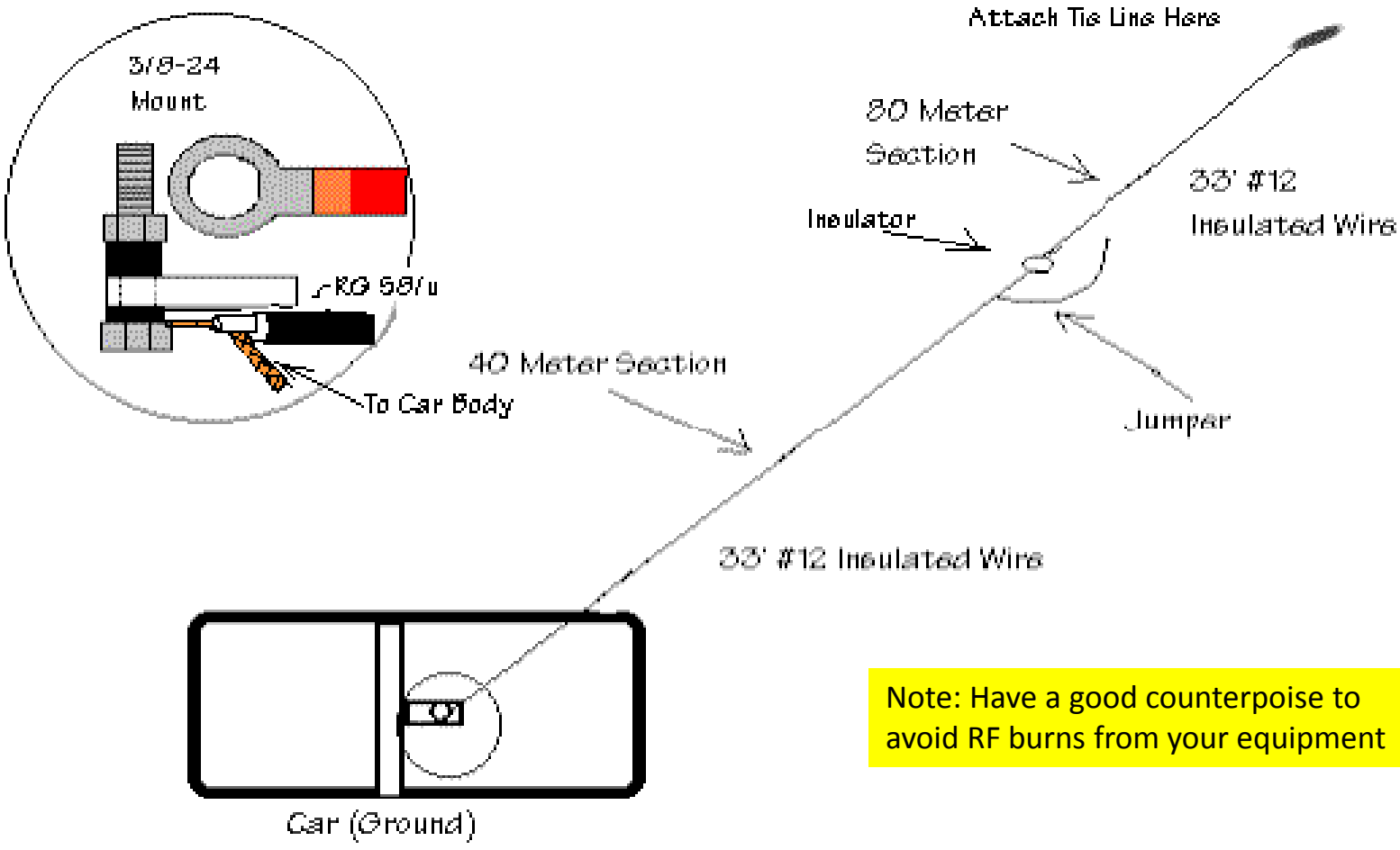
The **radiator** element (in red) has a length of 468/ frequency in megahertz. For example, 468/6.950=67.3 feet. If using insulated wire for the radiator, take about 3% off the total; in this case the final length is 65.3 feet.

“Maypole” Style

- Single support
- Dual Band
- Easy to erect
- AS-2259/GR



W7ARC Long Wire



NVIS Roadside Antenna

Note: Have a good counterpoise to avoid RF burns from your equipment

Drawing by ***W7ARC***

Short Dipole (Mobile whips)

Courtesy of WA5ZNU

Other Proven NVIS Antennas

- Shirley Dipole
- Patterson Loop
- Any horizontally polarized antenna will have an NVIS component in its radiation when placed below ¼ wavelength above ground

Antenna Tips

- Horizontal antennas seem to work best
- It's always better to have the base/net control station antenna higher above ground but that means the support system is more complicated
- Ideally, you want NVIS antennas to be "talking" to other NVIS antennas
- Lots of homebrew designs are available on the internet, try one!

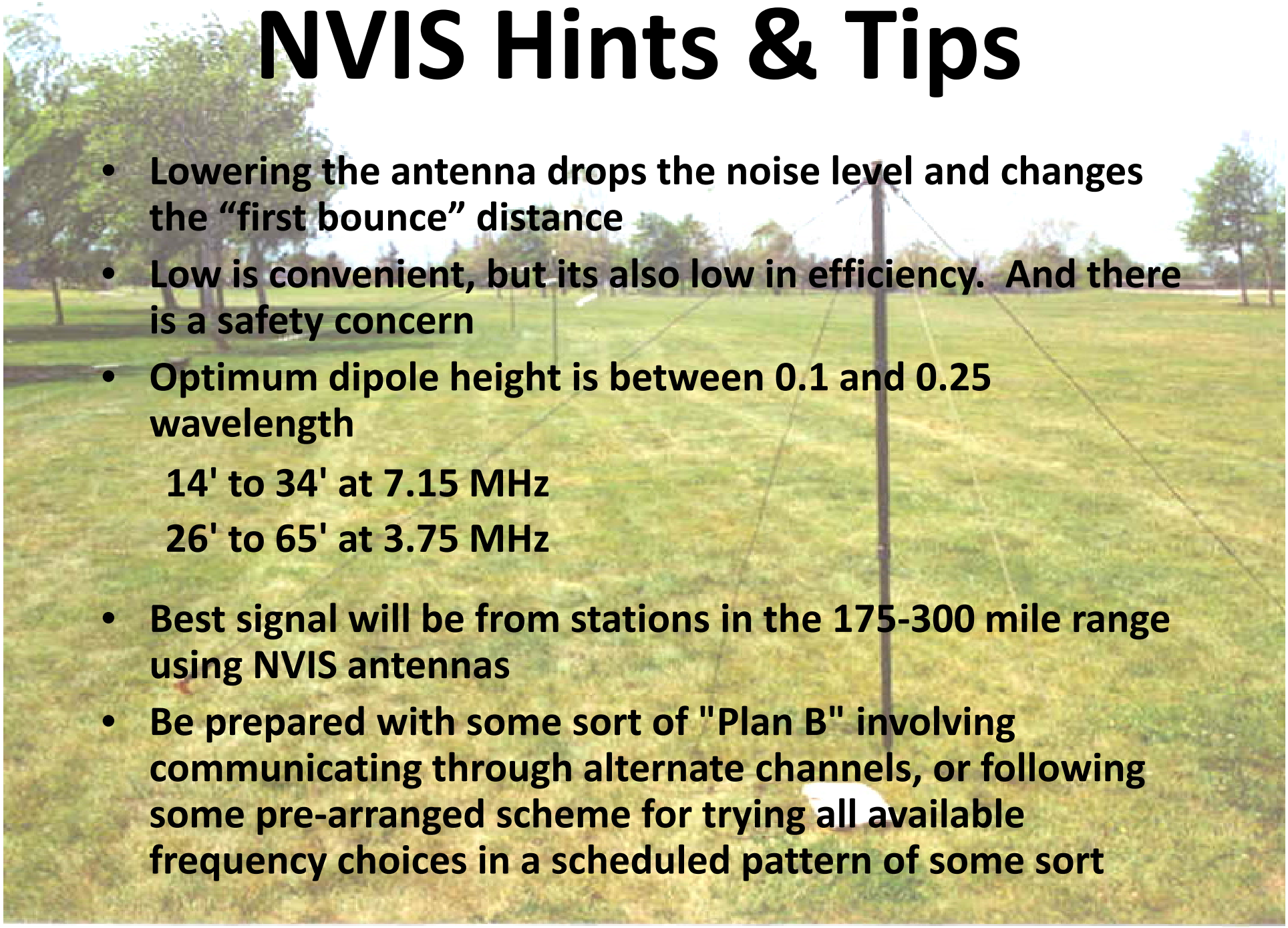
Safety First

Safety

- Always watch for overhead power lines and other electrical hazards when erecting antenna masts and wires
- Be aware of RF radiation hazards in the near-field when using low dipoles. Keep all people a safe distance away. For 100 watts, keep people at least 10' away
- Mark your antenna and guy wires with brightly colored ribbons to prevent people walking into them or better yet, establish a safety perimeter

Summary

NVIS Hints & Tips



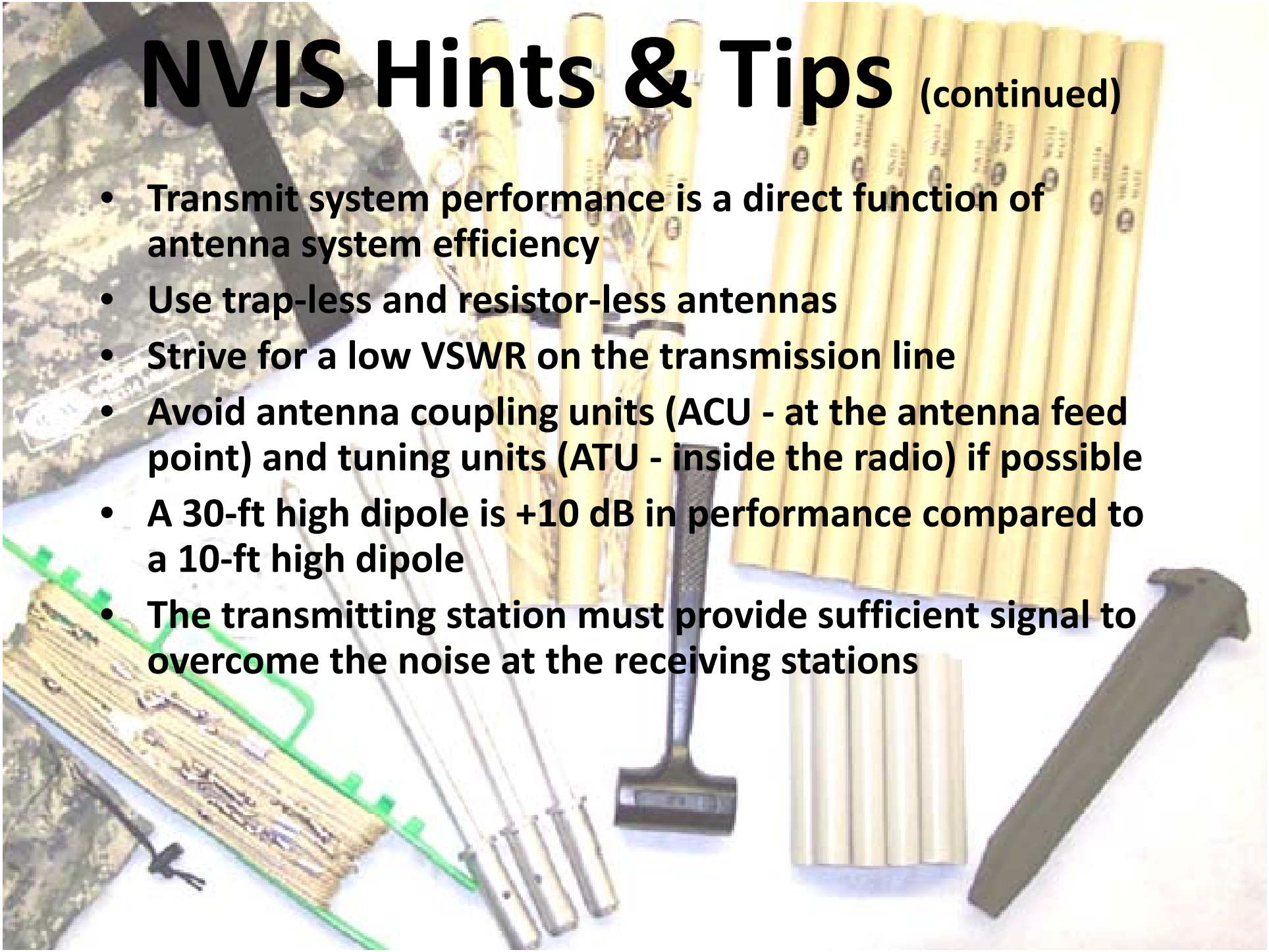
- Lowering the antenna drops the noise level and changes the “first bounce” distance
- Low is convenient, but its also low in efficiency. And there is a safety concern
- Optimum dipole height is between 0.1 and 0.25 wavelength

  14' to 34' at 7.15 MHz

  26' to 65' at 3.75 MHz

- Best signal will be from stations in the 175-300 mile range using NVIS antennas
- Be prepared with some sort of "Plan B" involving communicating through alternate channels, or following some pre-arranged scheme for trying all available frequency choices in a scheduled pattern of some sort

NVIS Hints & Tips (continued)



- Transmit system performance is a direct function of antenna system efficiency
- Use trap-less and resistor-less antennas
- Strive for a low VSWR on the transmission line
- Avoid antenna coupling units (ACU - at the antenna feed point) and tuning units (ATU - inside the radio) if possible
- A 30-ft high dipole is +10 dB in performance compared to a 10-ft high dipole
- The transmitting station must provide sufficient signal to overcome the noise at the receiving stations

Links

www.qsl.net/wb5ude/nvis/

www.athensarc.org/nvis.htm

www.athensarc.org/fm2418m.htm

www.w0ipl.com/ECom/NVIS/nvis.htm

www.co.missoula.mt.us/acs/ACS/NVISpage1.htm

www.co.missoula.mt.us/acs/ACS/N6VNG%20AS2259.htm

http://groups.yahoo.com/group/nvis/

http://www.co.missoula.mt.us/acs/documents/TM%20NVIS%20antenna.pdf

www.arrl.org/qst/2005/12/Straw.pdf

www.tactical-link.com/field_deployed_nvis.htm

www.sedata.net/nvis.html

www.cebik.com/wire/cb.html

Credits

- “What’s the deal about NVIS”? By Dean Straw, N6BV, *QST* Dec 2005
- “NVIS Operations” by Ed Farmer, AA6ZM, *QST*, Jan 1995
- “The NVIS - A Low Antenna for Regional Communications” by Albert Pion, KK7XO, *QST*, Jun 2002
- “NVIS Propagation and Antennas: Some Background Basics” by L.B. Cebik, W4RNL
- “Understanding NVIS Antennas & Propagation” by Harold Melton, KV5R, 2002, 2006
- US Army field manual "FM 24-18" (appendix M) by Dave Fiedler
- “Antenna Performance for Near Vertical Incidence Skywave Communications” by Dave Fiedler
- “NVIS Antenna Fundamentals” by Edward Farmer
- “Near Vertical Incidence Sky Wave (NVIS) Propagation” by Marc Tarplee, N4UFP
- “Near Vertical Incidence Skywave (NVIS) Antenna” by Pat Lambert, W0IPL

Remember…


"TONE" BURST
by GMOMEN
How's the NVIS experiment going, Tone? Over
ROTTEN! Getting nowhere!
Well, you've got to start by getting HORIZONTAL and LOW.
Yeah... well I've got that covered....

Questions