NVIS

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NVIS

- What is NVIS ?
- Means Near-Vertical Incidence Skywave
- Opposite of DX (long – distance)
- Local - to - Medium Distance (0 – 250 SM)

NVIS By Other Names

- AKA:
- Australian District Antenna
- Russian Zenith Radiation
- Marine Showerhead Antenna
- Short Range Ionospheric Propagation

A History of NVIS

- NVIS in WW II

  For D-Day : Successful communications between Operations HQ at Uxbridge, forward control ship USS Ancon and CAS landing parties was achieved using horizontal antennas and high-angle skywave, following poor results with verticals – the system was developed by Dr. Harold Beverage (of long antenna fame !)

  Germans also used NVIS Mobile antennas in WW II, visible in many vehicle photos.

NVIS on D-Day

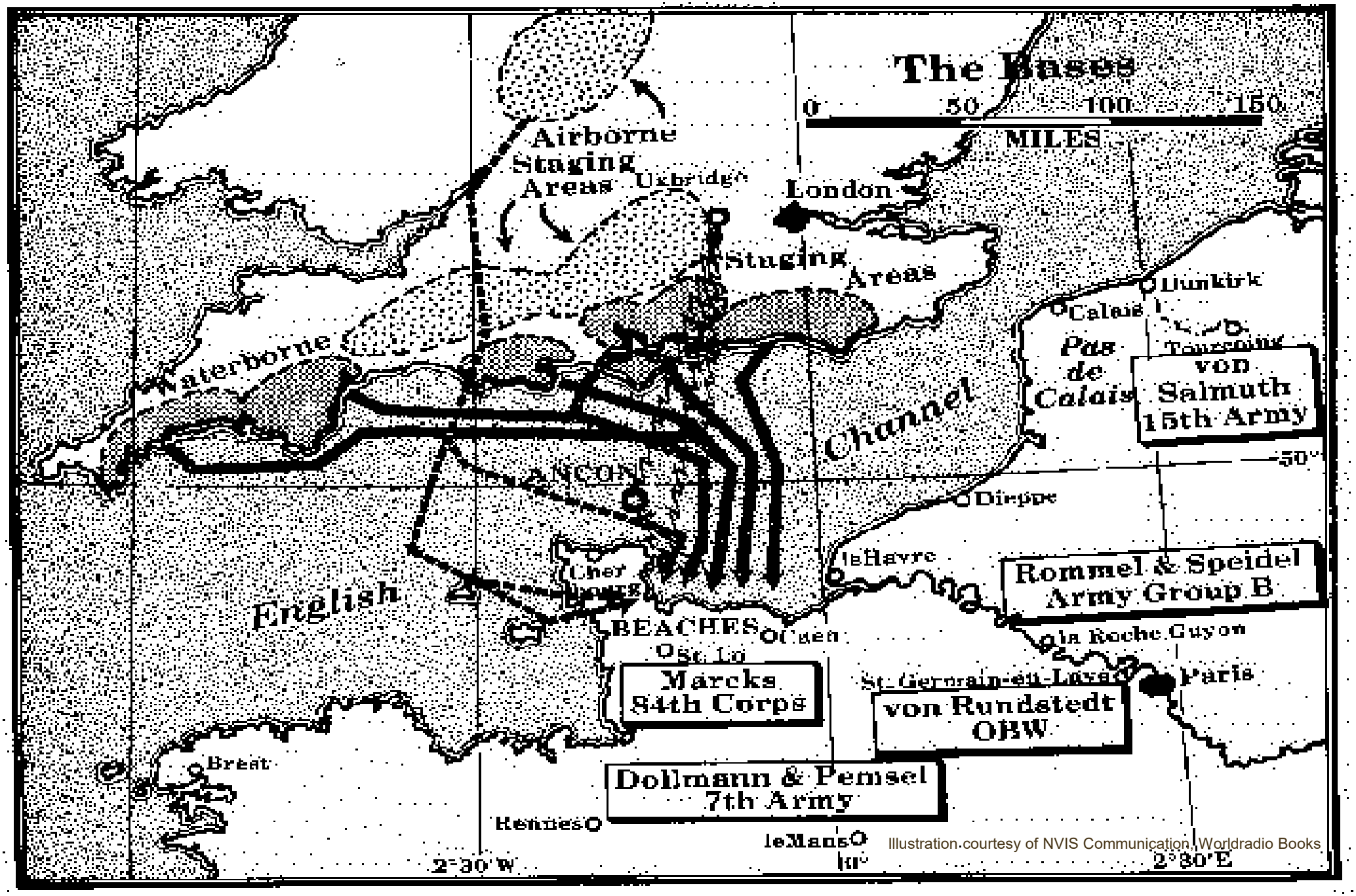


Illustration courtesy of NVIS Communication, Worldradio Books

WWII German Radio Vehicle with NVIS Antenna

USMC “Rat Tail” Mobile NVIS (Circa “Desert Storm” 1990-91)

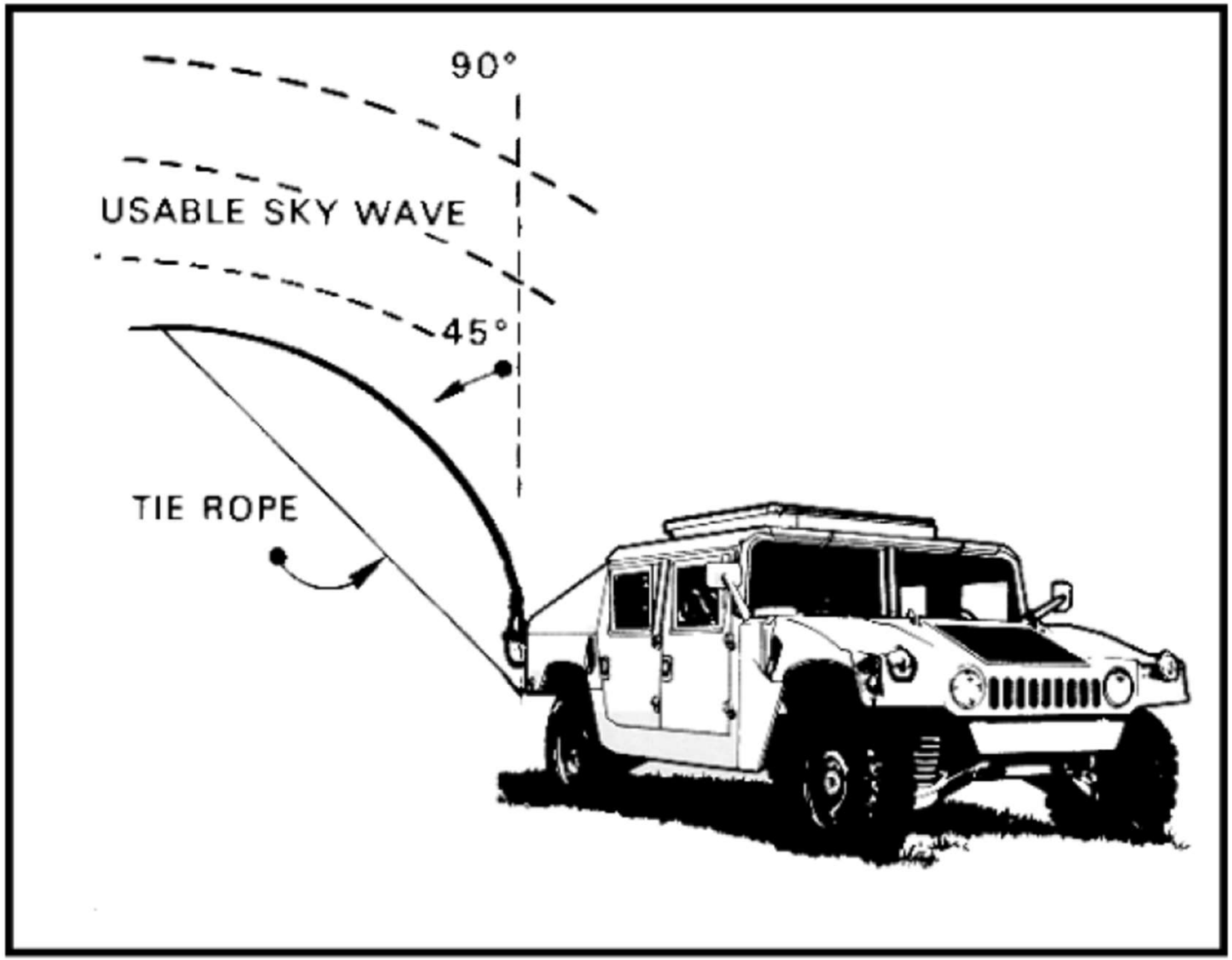


Figure M-9. Tying the whip antenna down.

HF Renaissance in the U.S. Army

- Lt.Col Stephen Hamilton, Ph.D at USMA says the Army is revitalizing HF/NVIS.
- SatCom “bandwidth suck”.
- Russia / PRC ASAT kinetic threats
- Direction finding.
- Russian/ PRC advances in GPS jamming.
- GPS Jamming defeats GPS time constant.

HF Renaissance in the U.S. Army (cont.)

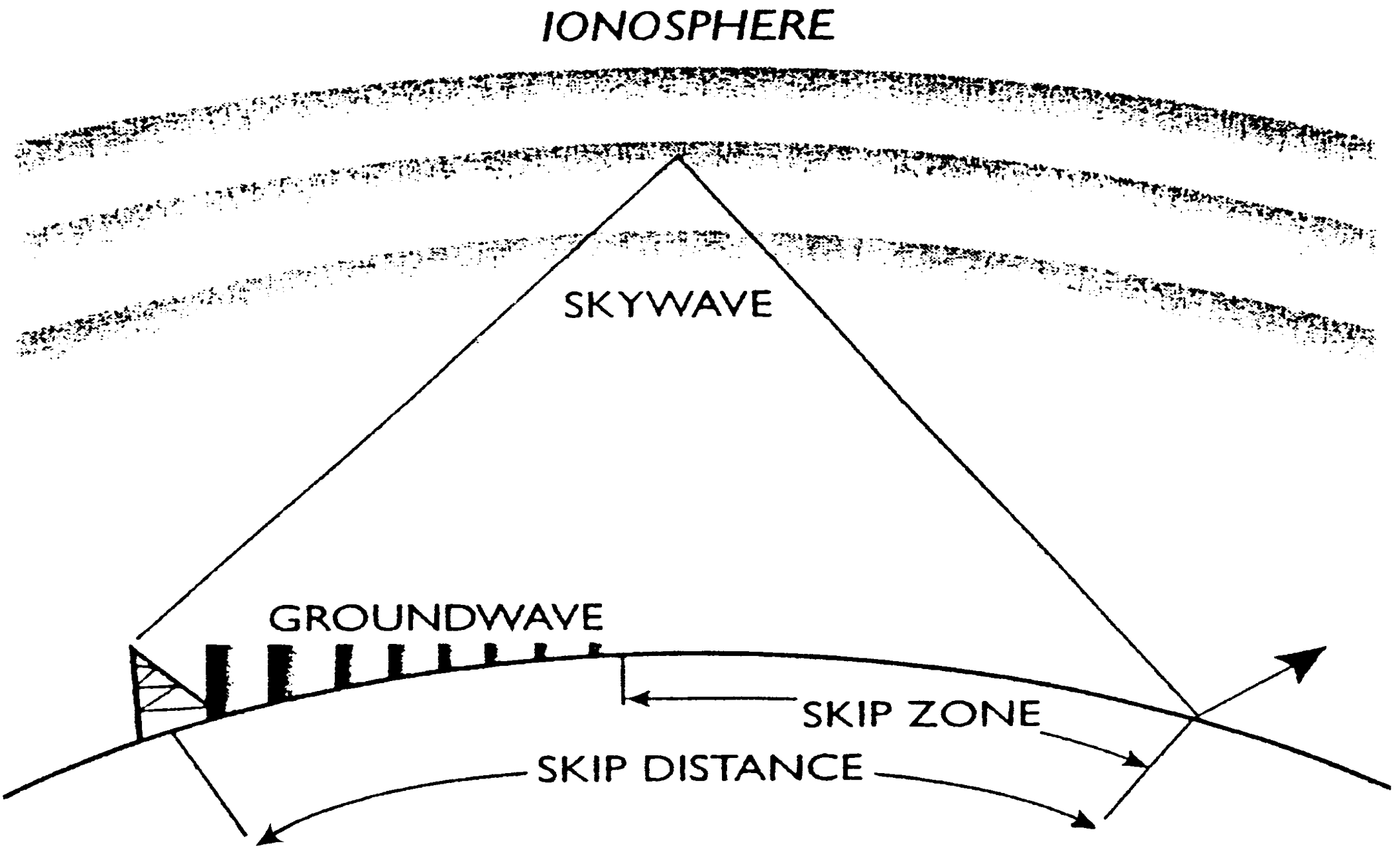
- Dr. Hamilton and team conducted experiments at NTC Ft. Irwin, CA.
- Ham Buddipole antennas, Elecraft radio.
- SSB voice over 3000’ mountain out to 25 Km at 25 watts.
- FT8 and JS8 were used down to 100mW!*
  - * not detectable by latest DF technology!
- 10th MT Div. is the current USA HF experts. (2022)

‘Ordinary’ Propagation

- To travel a long distance, the signal must take off at a LOW angle from the antenna
  – 30 degrees or less
- This is so that it can travel the maximum distance before it first arrives at the Ionosphere
- Long gap before signal returns to earth – the part in between the origin point and the end of the ground wave is the so-called Skip (or Dead) Zone

‘Ordinary’ Propagation

Illustration courtesy of Barrett Communications Pty



NVIS Propagation

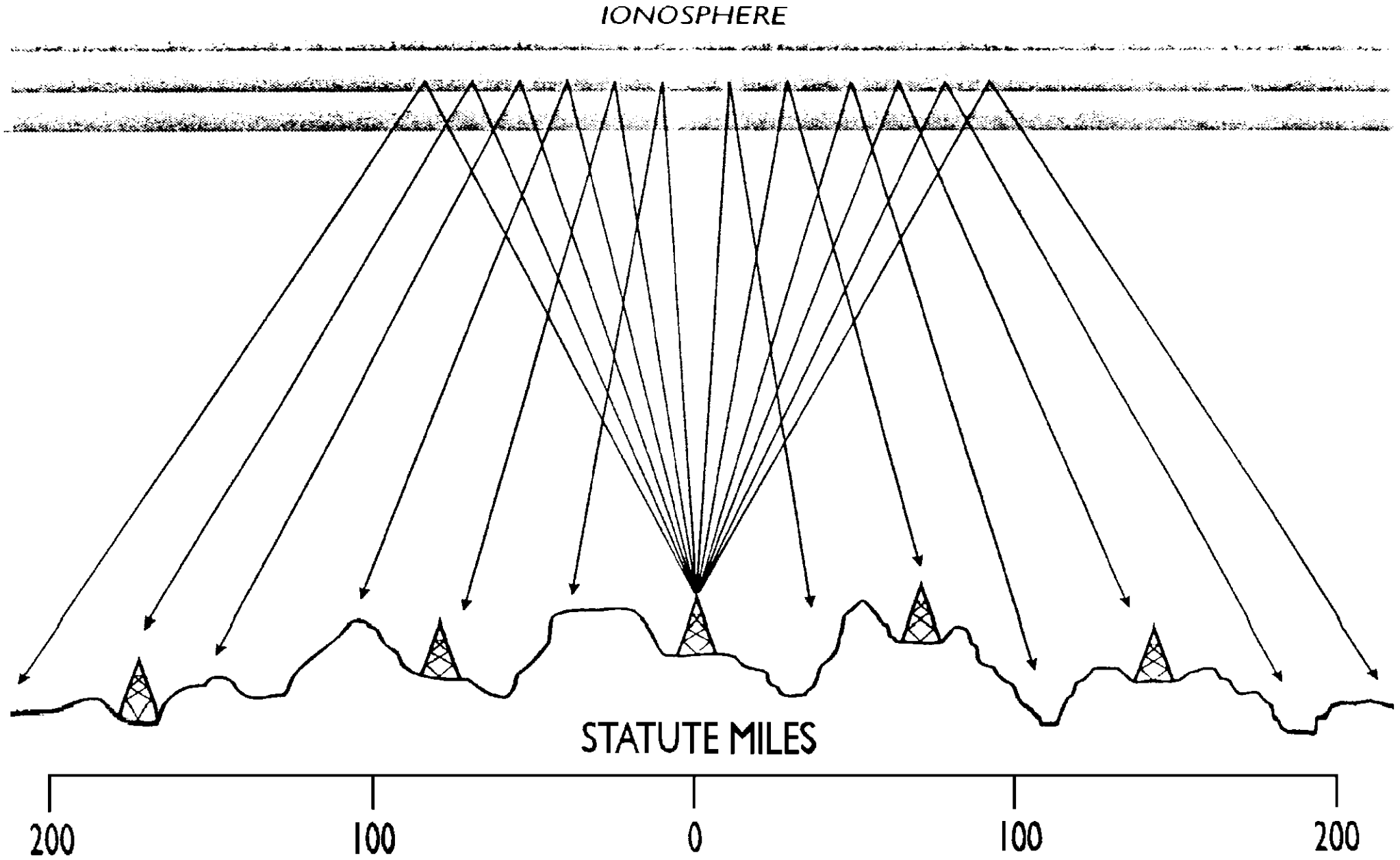
- To travel a local - medium distance, the signal must take off at a HIGH angle from the antenna – typically 60 – 90 degrees

- This returns from the Ionosphere at a similar angle, covering 0 – 250 SM

- It thus eliminates the Skip (or Dead) Zone – like taking a hose and spraying it into an umbrella !

NVIS Propagation

Illustration courtesy of Barrett Communications Pty



Using NVIS successfully

- HIGH angle of radiation from antenna
- Minimise ground wave, as it will interfere with the returning skywave
- Most importantly, CHOOSE THE CORRECT FREQUENCY BAND – go too high in frequency and your signal will pass through straight into space!

Choosing the right frequency

- The Ionosphere – D, E, F1 & F2 layers
- D and to a lesser extent, E layers attenuate and absorb signal
- Best returns from F2 layer
- At any one time we need to know the frequency of the F2 layer – The Critical Frequency or: foF2
- Optimum frequency for NVIS work around 10% below this

The Ionosphere

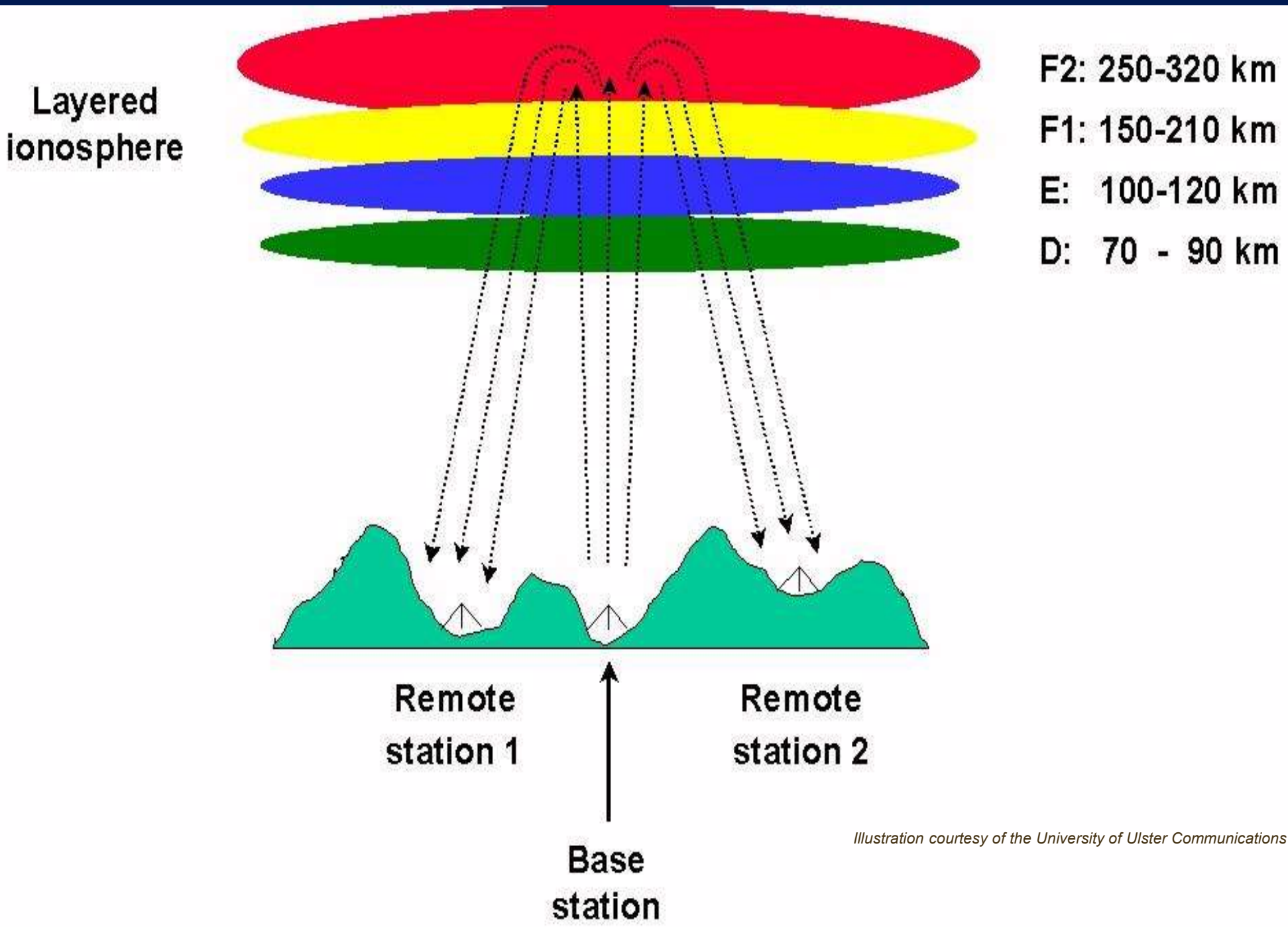


Illustration courtesy of the University of Ulster Communications Centre

NVIS - Frequency and Time

- In practice, highest NVIS frequency can reach 15 MHz band. Lowest can go down down to1.81 MHz band
- ‘Higher’ frequency band during day, ‘Middle’ frequencies afternoon/evening, ‘Lower’ frequencies at night
- Frequencies also affected by time of year and period of sunspot cycle
- For best results, these three different frequency ‘bands’ required

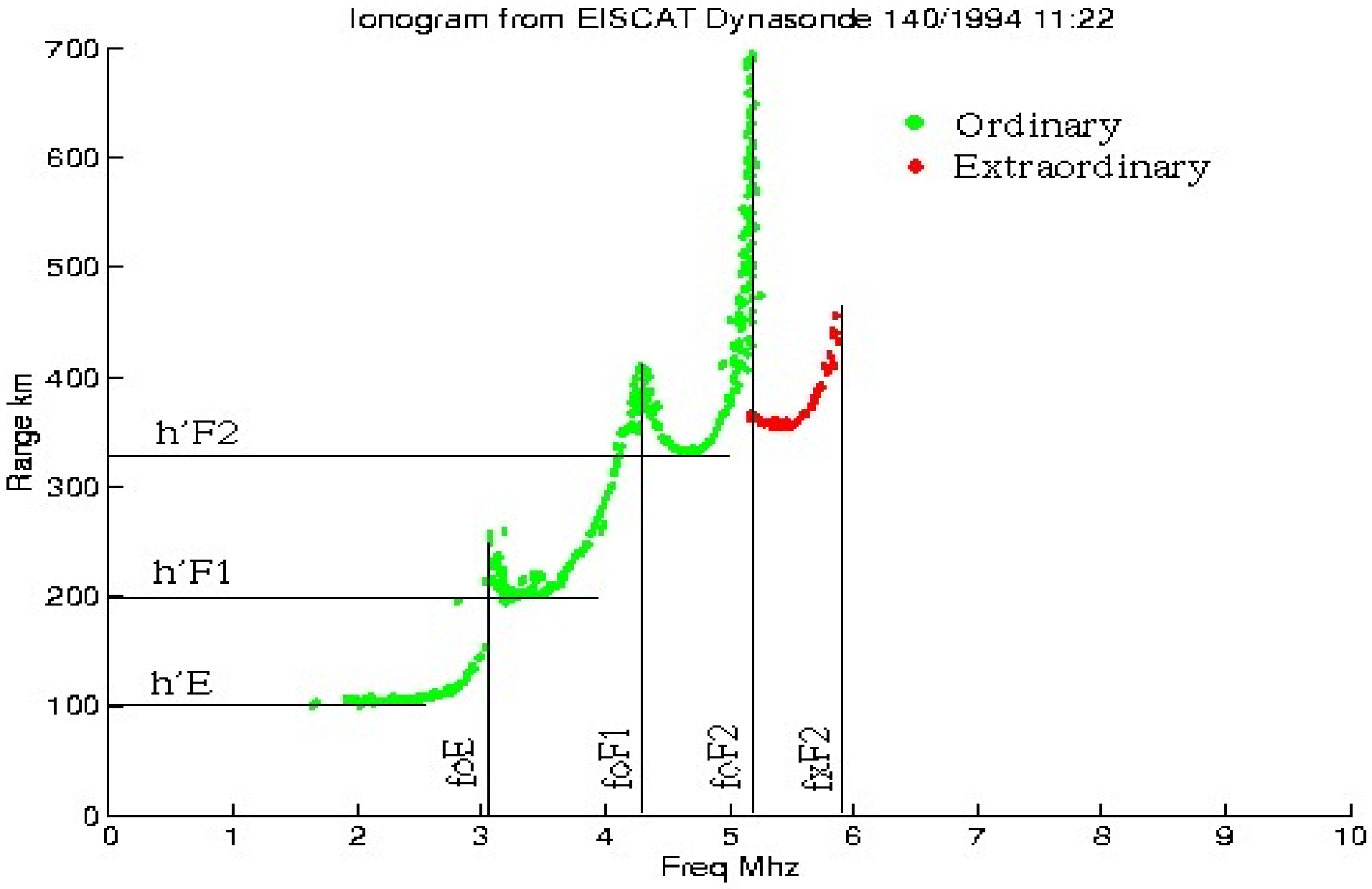
NVIS – The Critical Frequency

- The Critical Frequency is the key to successful NVIS working
- The Critical Frequency (or foF2) is the highest frequency at any one time that a signal transmitted vertically will be returned to earth. Anything above this passes into Space
- As we are interested in vertical signals for NVIS, then the value of the Critical Frequency (foF2) at any one time is of great importance to us
- How can we find or estimate foF2 ?

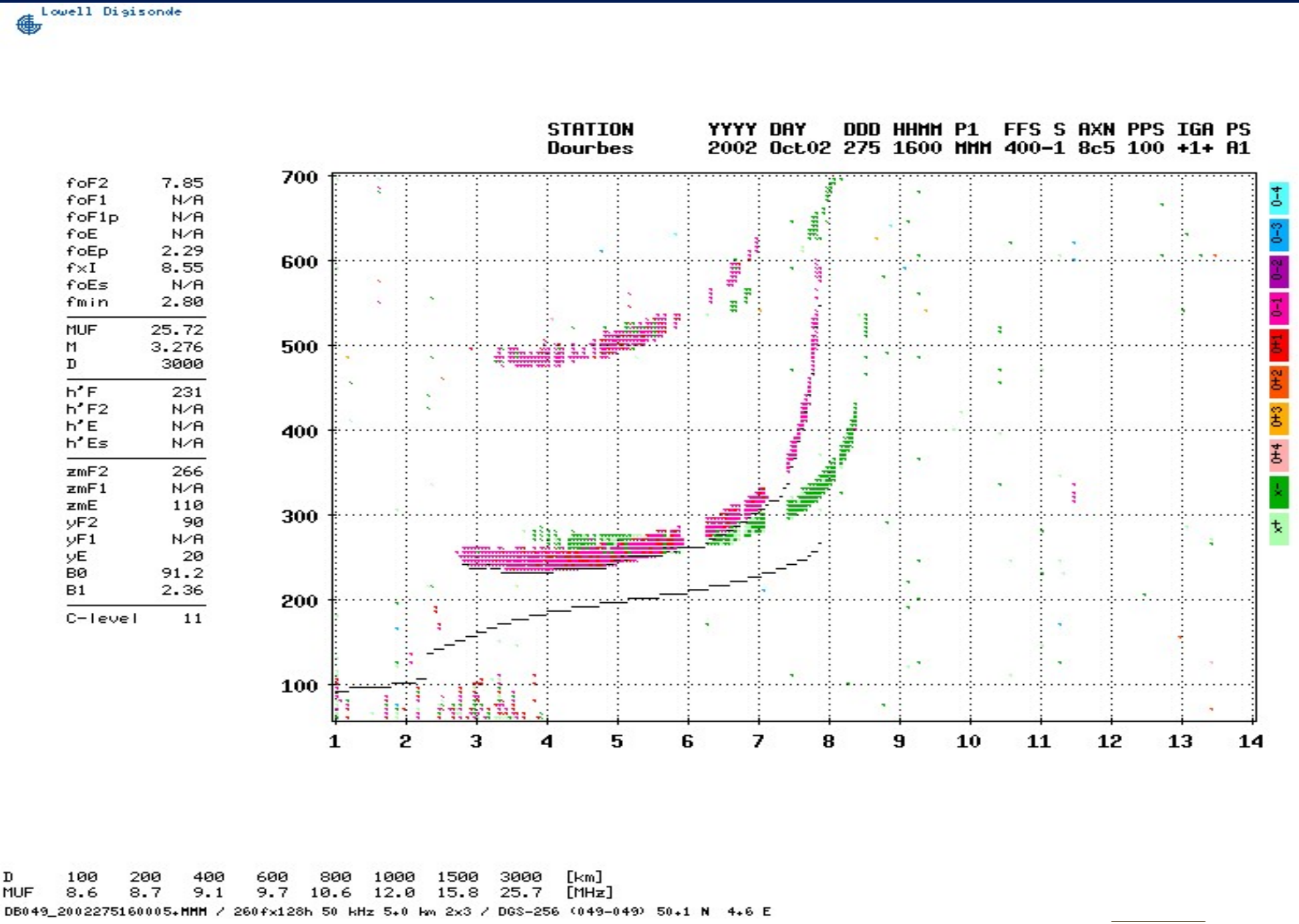
NVIS – Finding The Critical Frequency

- Real-time web information from Ionosondes
- Websites offering Critical Frequency predictions: – RAL STIF, IPS Euromaps
- Software Propagation prediction tables or similar printed material: - W6ELprop etc.
- Rule-of-thumb:- ‘higher’ band by day, ‘middle’ band afternoon/evening transition, ‘lower’ band nightime

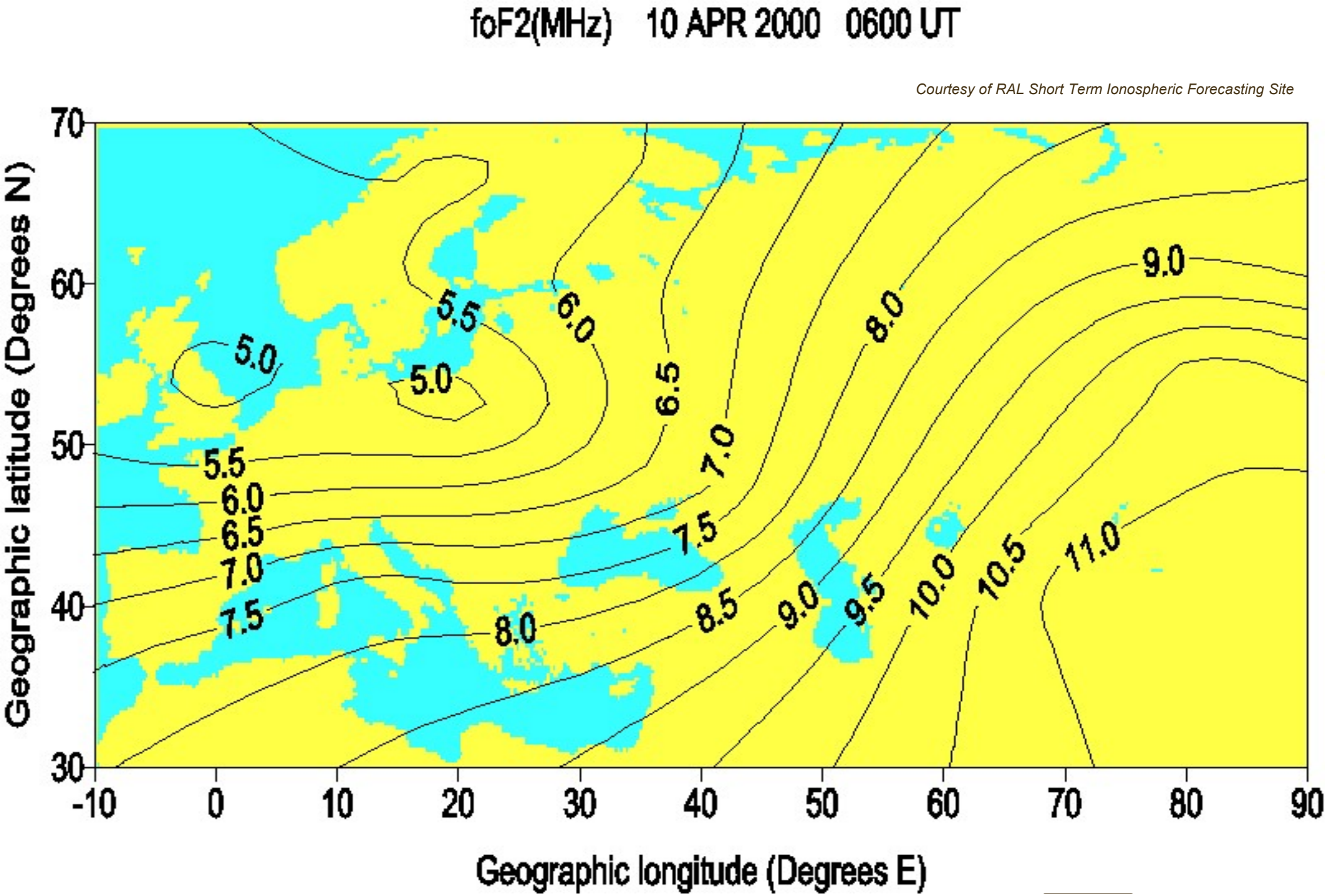
Interpreting an Ionogram



Real –Time Ionogram



Ionospheric Prediction Map



NVIS – For the Radio Amateur

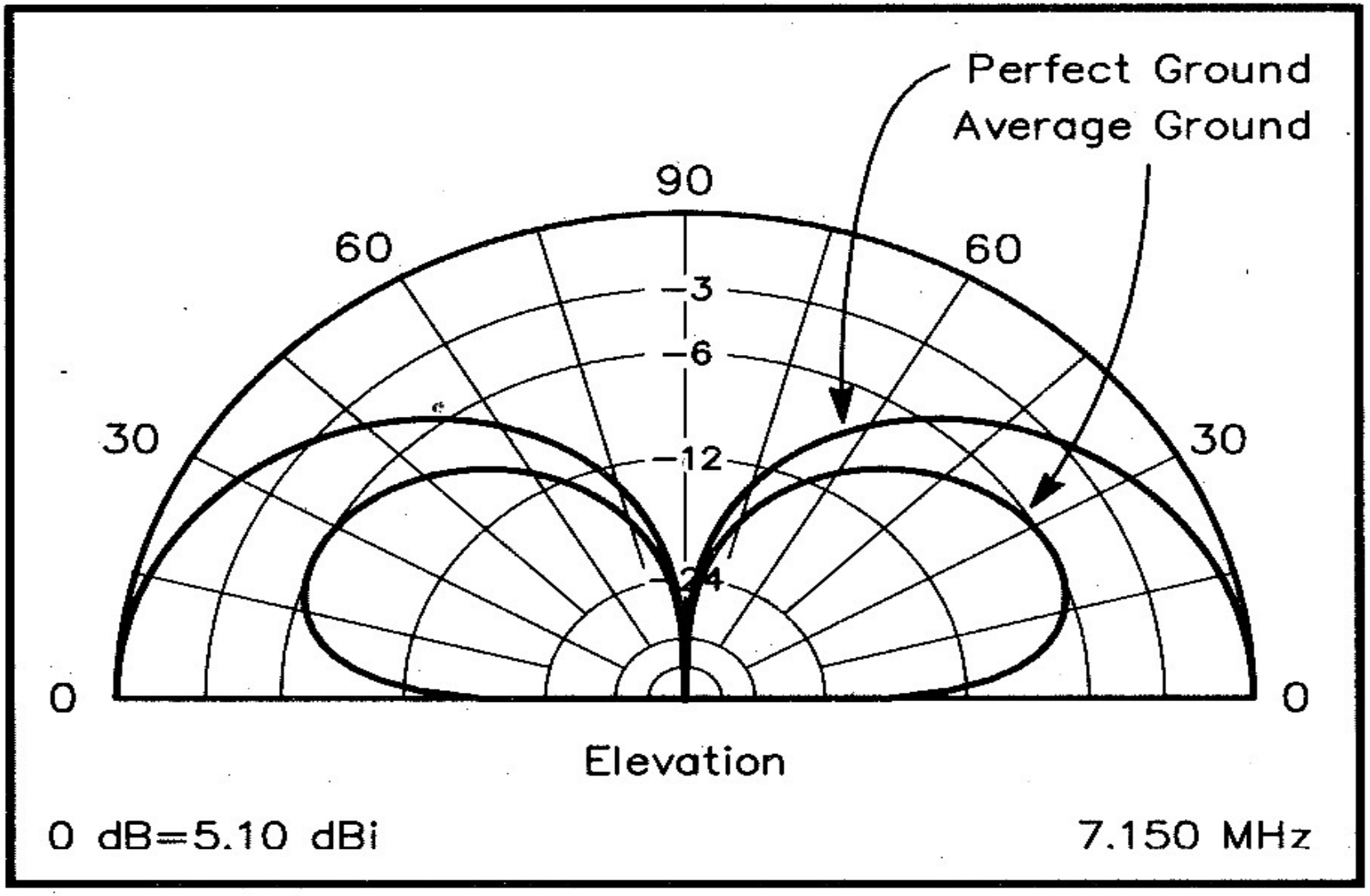
- In practice, 7 MHz (40m) usually 'highest' band
- 3.5 MHz (80m) next lowest
- 1.81 MHz (160m, 'Topband') the lowest
- 80m and 160m strongly affected during the day by absorption from the D-layer, plus noise at night and varying times of the year
- Need for a 'middle' transition frequency around 5 MHz

NVIS – The Antenna Side

- Need high angle (60-90°) radiation for NVIS.
- Verticals are poor– predominantly low angle.
- Half wave dipole at 'text book' height – 0.5 wavelength produces low angle radiation, BUT, if lowered to 0.25 wavelength or below, produces high angle radiation !
- Not too low, though – some earth losses. A reflector wire or earth mat can reduce loss.

Vertical = No High Angle Radiation

Courtesy of ARRL Handbook

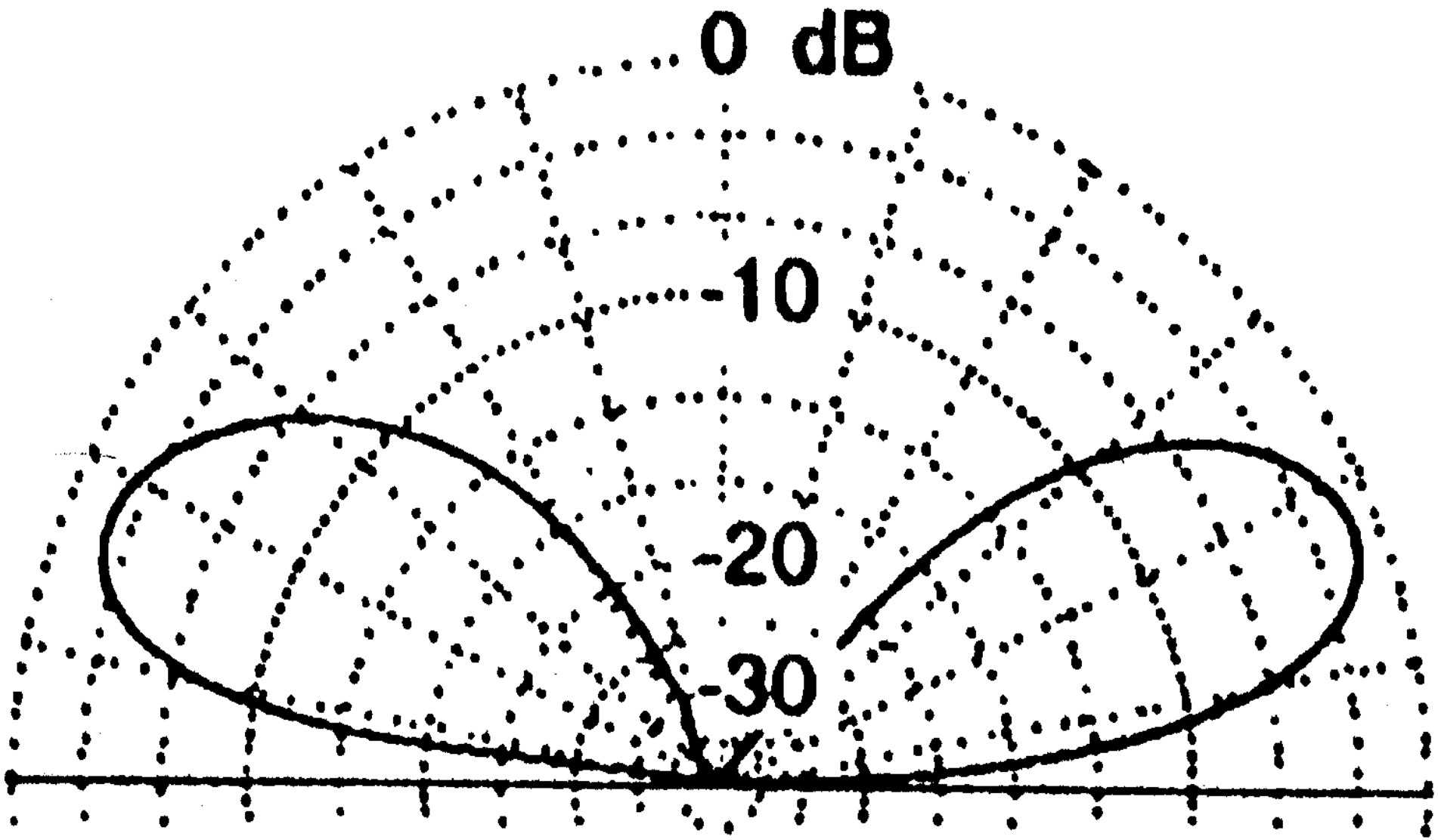


Horizontal dipole at 'textbook' height

- Textbooks say that for a horizontal dipole to radiate low angle radiation, it must be half (0.5) a wavelength above ground

- In the case of the lower bands such as 80 and 160m, this would be pretty high!

Horizontal dipole at 'textbook' height

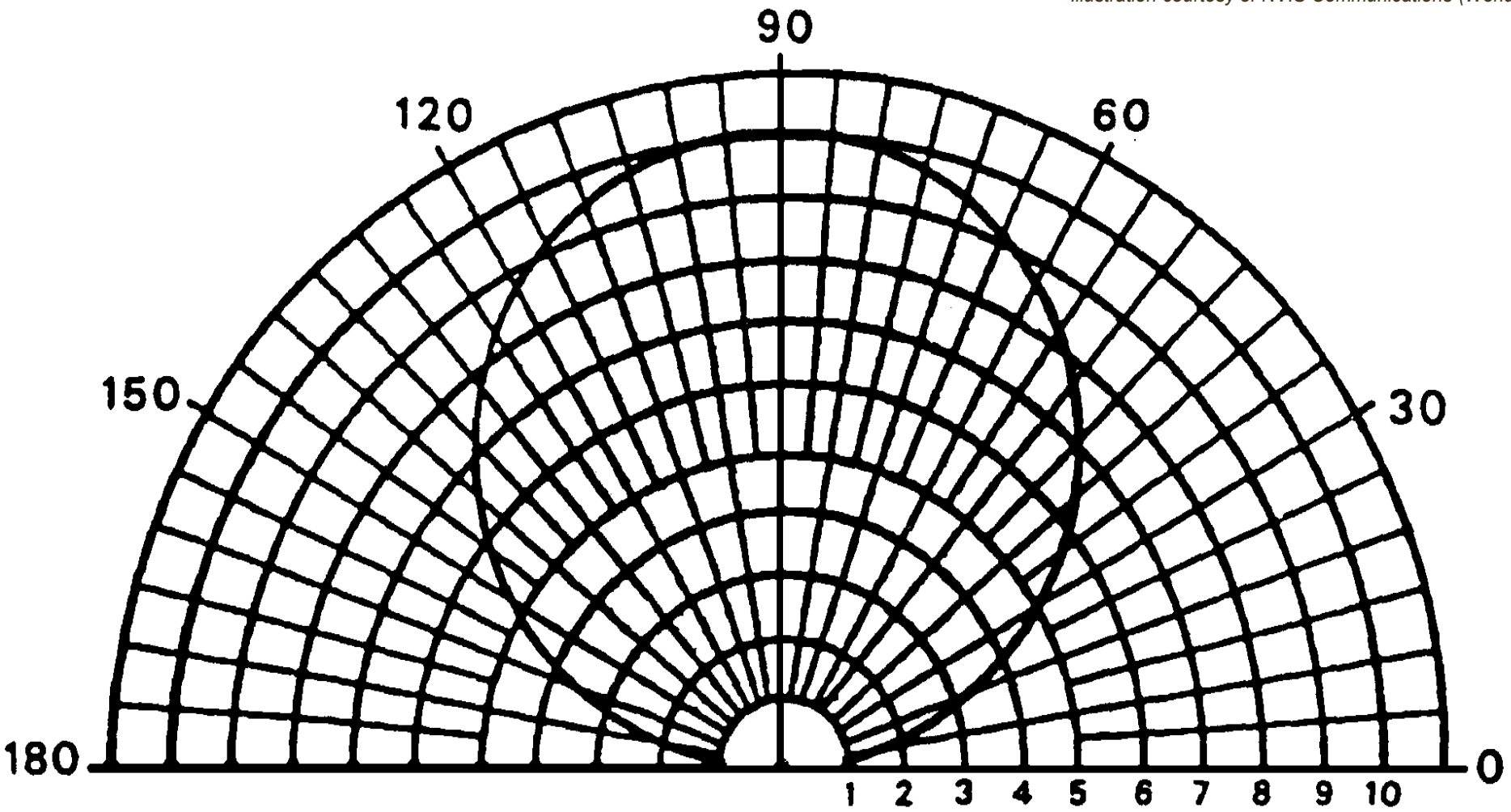


Low Horizontal dipole = High Angle

- If the height of the dipole is lowered, the angle of radiation becomes higher and the low angle radiation starts to disappear
- The optimum amount of high angle radiation is obtained at a quarter- (0.25) wavelength above ground
- Going lower than 0.25 causes efficiency loss
- In practice 0.25 – 0.15 wavelength heights used for NVIS

Low Horizontal dipole = High Angle

Illustration courtesy of NVIS Communications (Worldradio Books)



Home Brew NVIS Antenna - VK4ION

NVIS – Monoband Antennas

- The dipole is essentially a single band antenna
- There are also a couple of special higher-gain single band NVIS antennas –

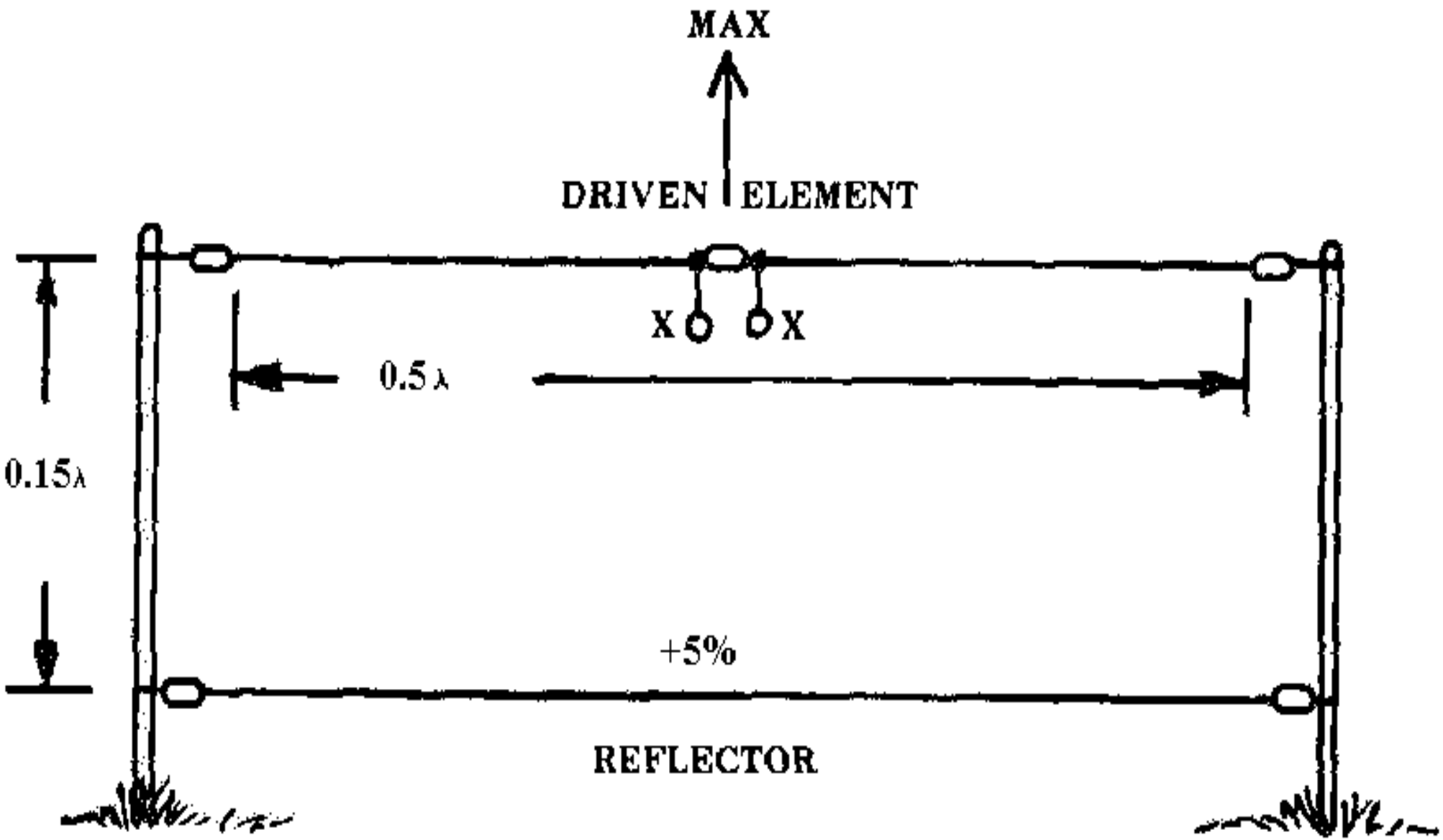
  Dipole with reflector.

  The Shirley.

  The Jamaica.

NVIS – Dipole with Reflector

Illustration courtesy of NVIS Communications (Worldradio Books)



NVIS – The Shirley Antenna

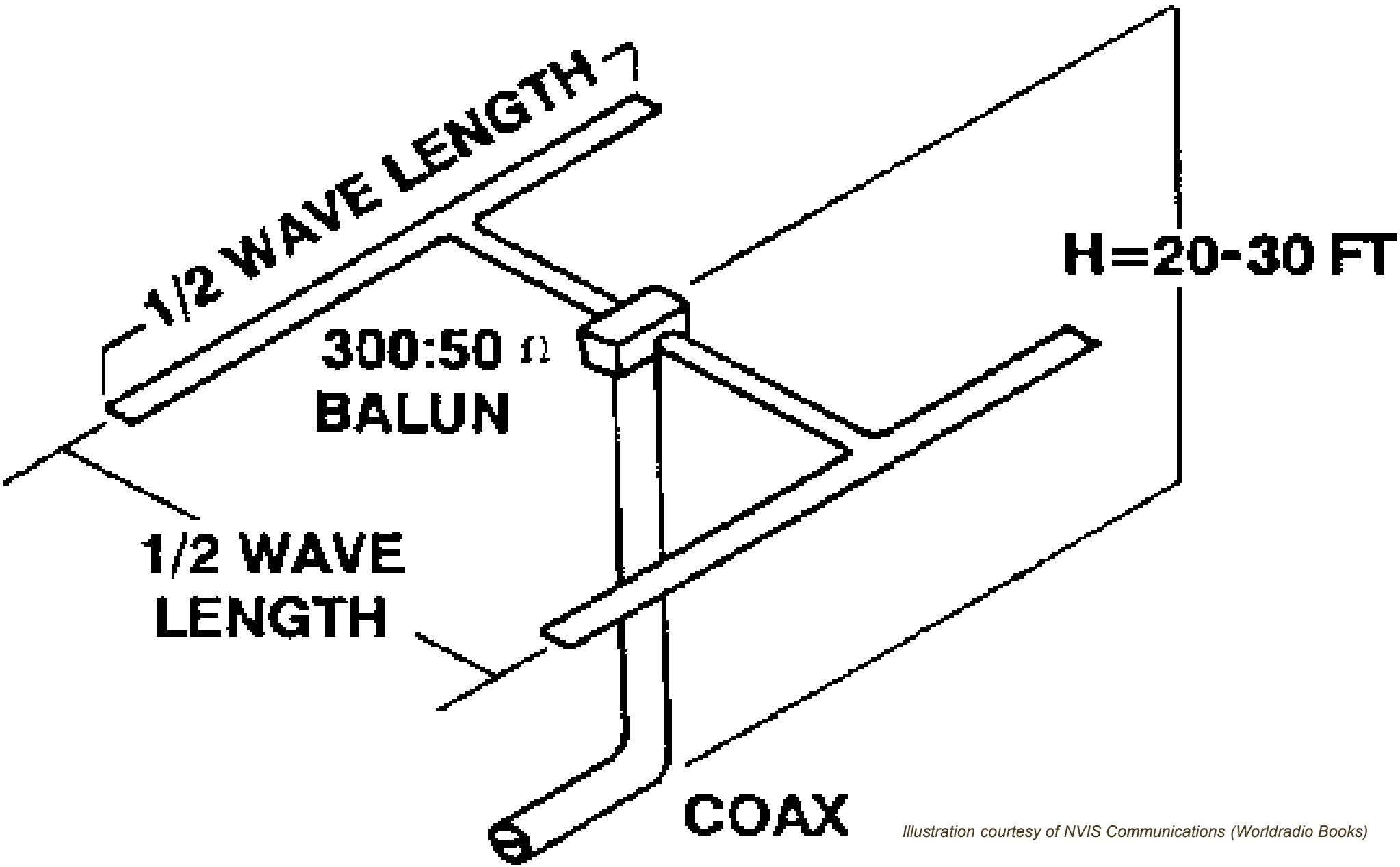


Illustration courtesy of NVIS Communications (Worldradio Books)

NVIS – The Jamaica Antenna

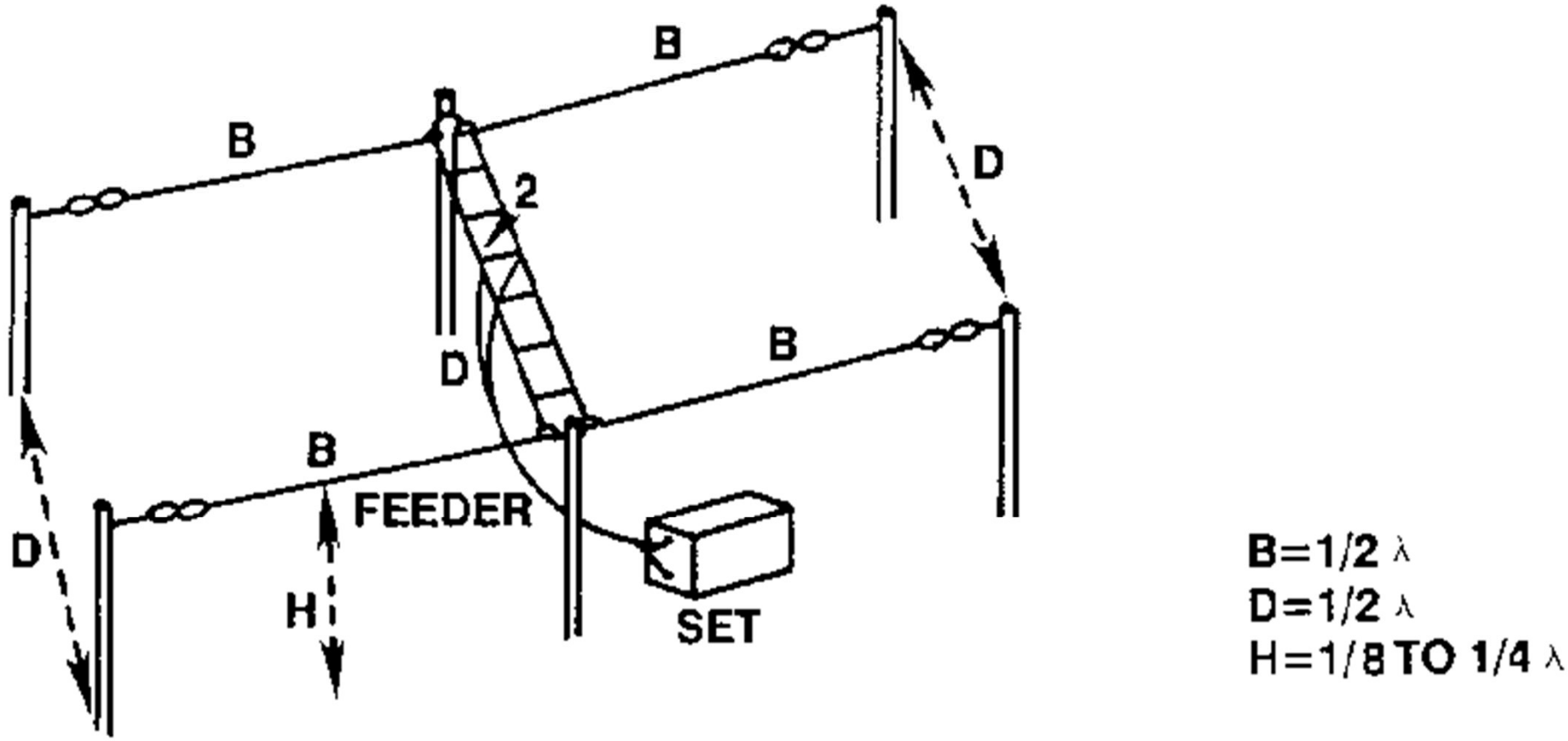


Figure 6. Jamaica antenna (Can be built from standard antenna kits AN/GRA-50; has four times the gain of the dipole antenna.)

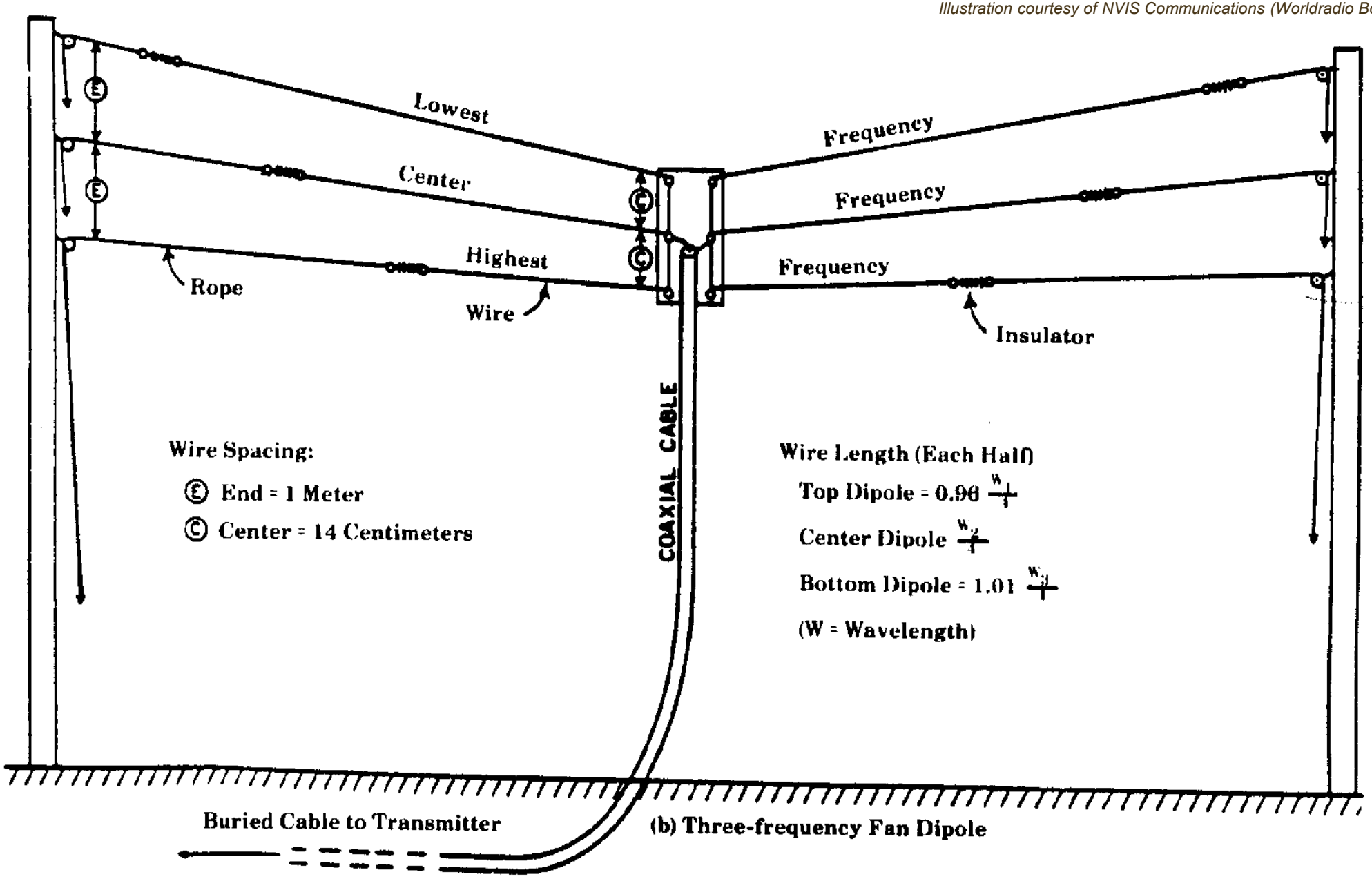
Illustration courtesy of NVIS Communications (Worldradio Books)

NVIS – Multiband Antennas

- As mentioned earlier, at least three different frequency bands are needed for successful 24 hr NVIS operation and so multi or wideband antennas are used
- Simple ones include long wire, inverted-L, Shallow (120°) Inverted-Vee Doublet with balanced feedline, full-wave low (0.15-0.25λ) horizontal loop (reflector could also be used below this)
- Other multiband antennas can be used -

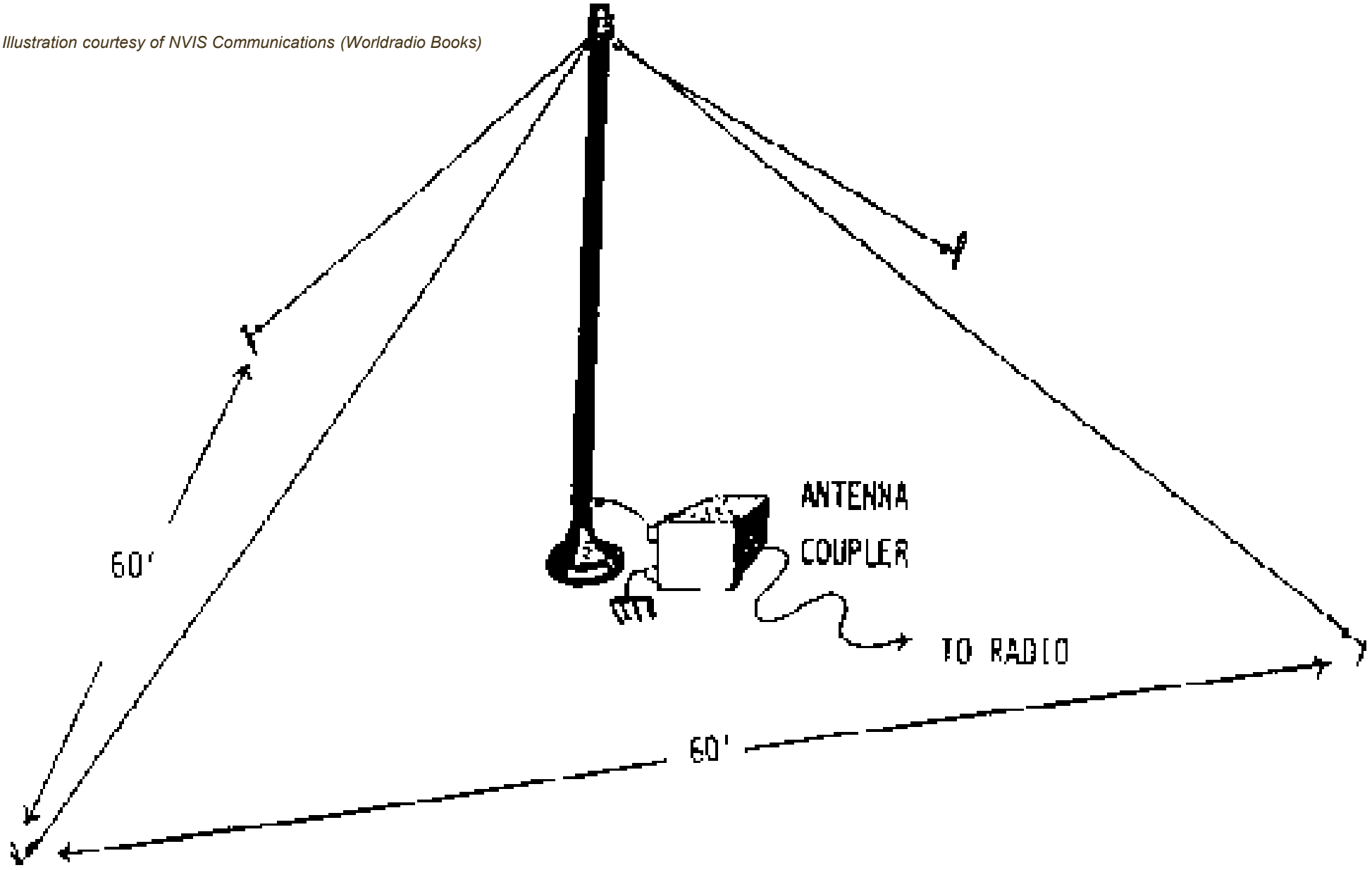
NVIS – The Fan Dipole

Illustration courtesy of NVIS Communications (Worldradio Books)



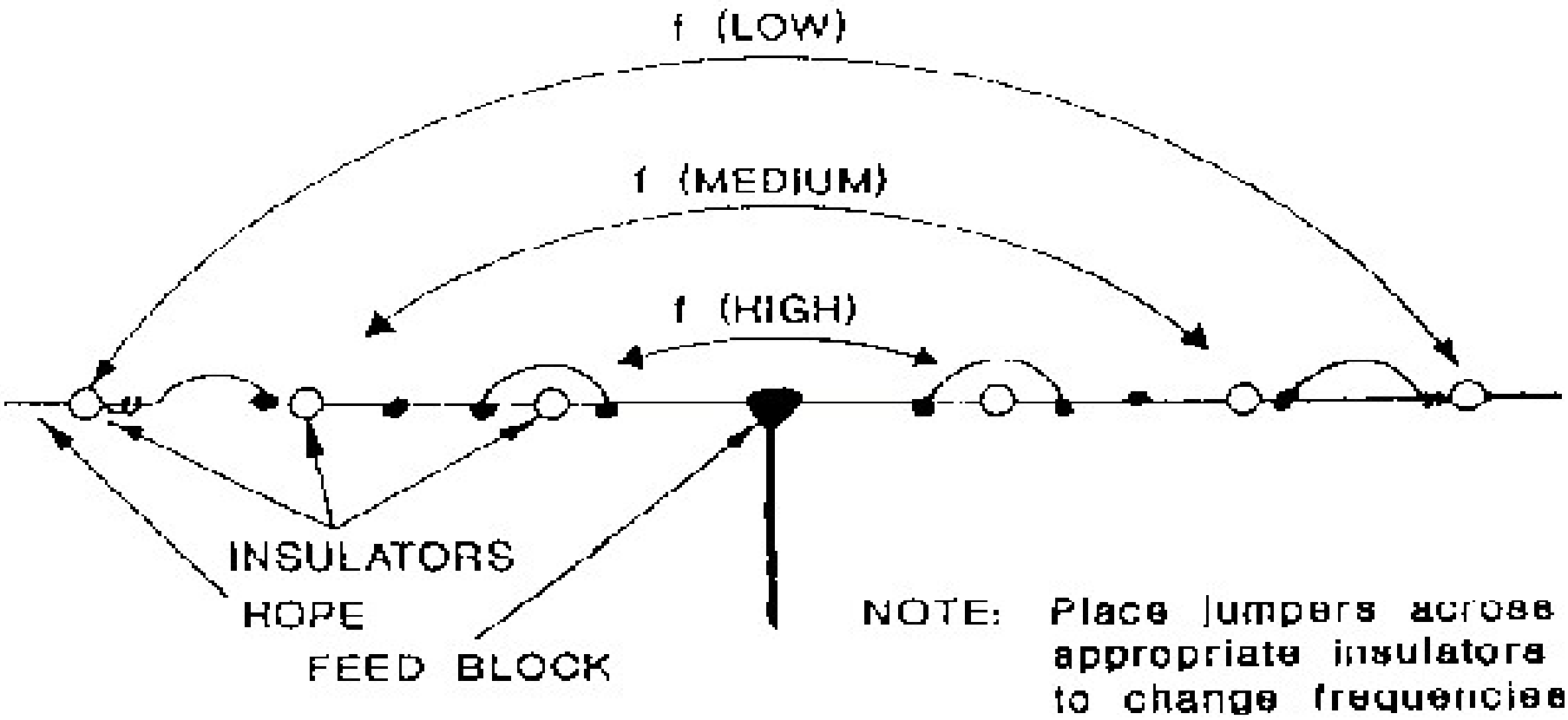
NVIS – The AS2259 or 'Collins' Antenna

Illustration courtesy of NVIS Communications (Worldradio Books)



NVIS – The Jumpered Doublet

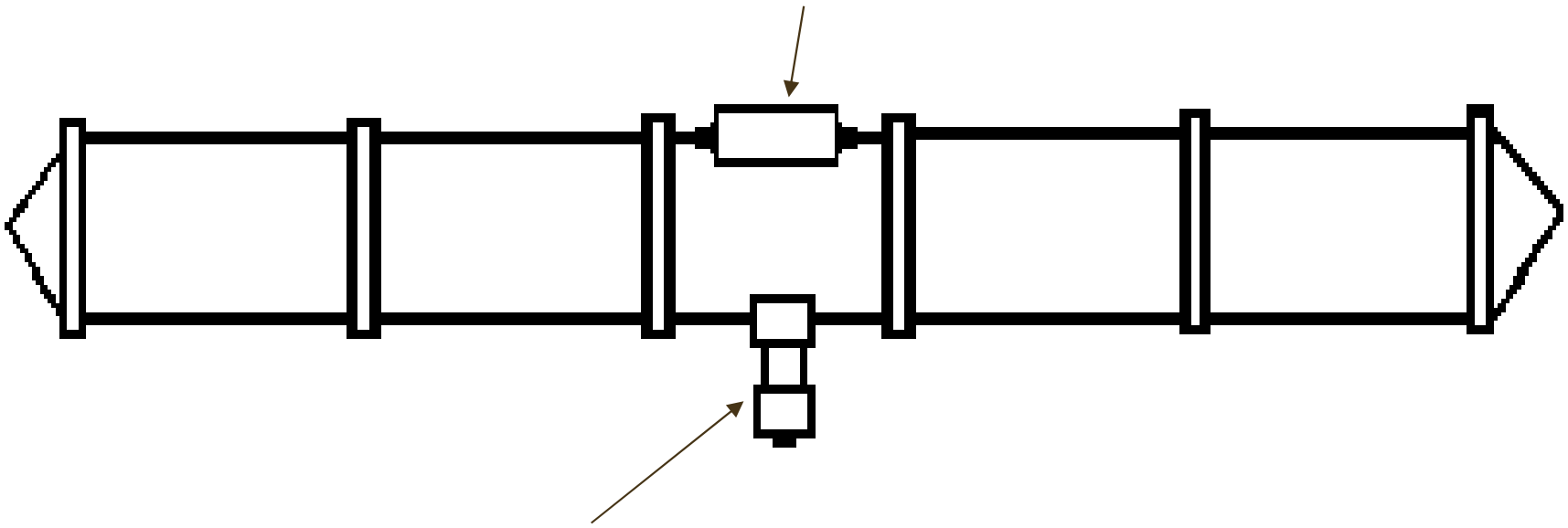
Illustration courtesy of NVIS Communications (Worldradio Books)



NVIS –Wideband Folded Dipole (T2FD)

Antenna total length approx 90ft

600 Ω Terminating Resistance/Balancing Network



12 : 1 Stepdown Balun to 50 Ω

Example – Barker & Williamson BWD 1.8 – 30 MHz Wideband Folded Dipole

Courtesy of Barker & Williamson Manufacturing Inc.

NVIS – Mobile Operation

- You can use a whip for NVIS – but NOT VERTICAL ! You can either

  a) Bend the whip back over the vehicle as flat as possible without breaking.

  b) Bend the whip back away from the vehicle at least 45°- OK when stationary, but not recommended mobile ! Keep your distance !

- You can use loops – either

  a) A fore – aft loop or b) Magnetic Loop

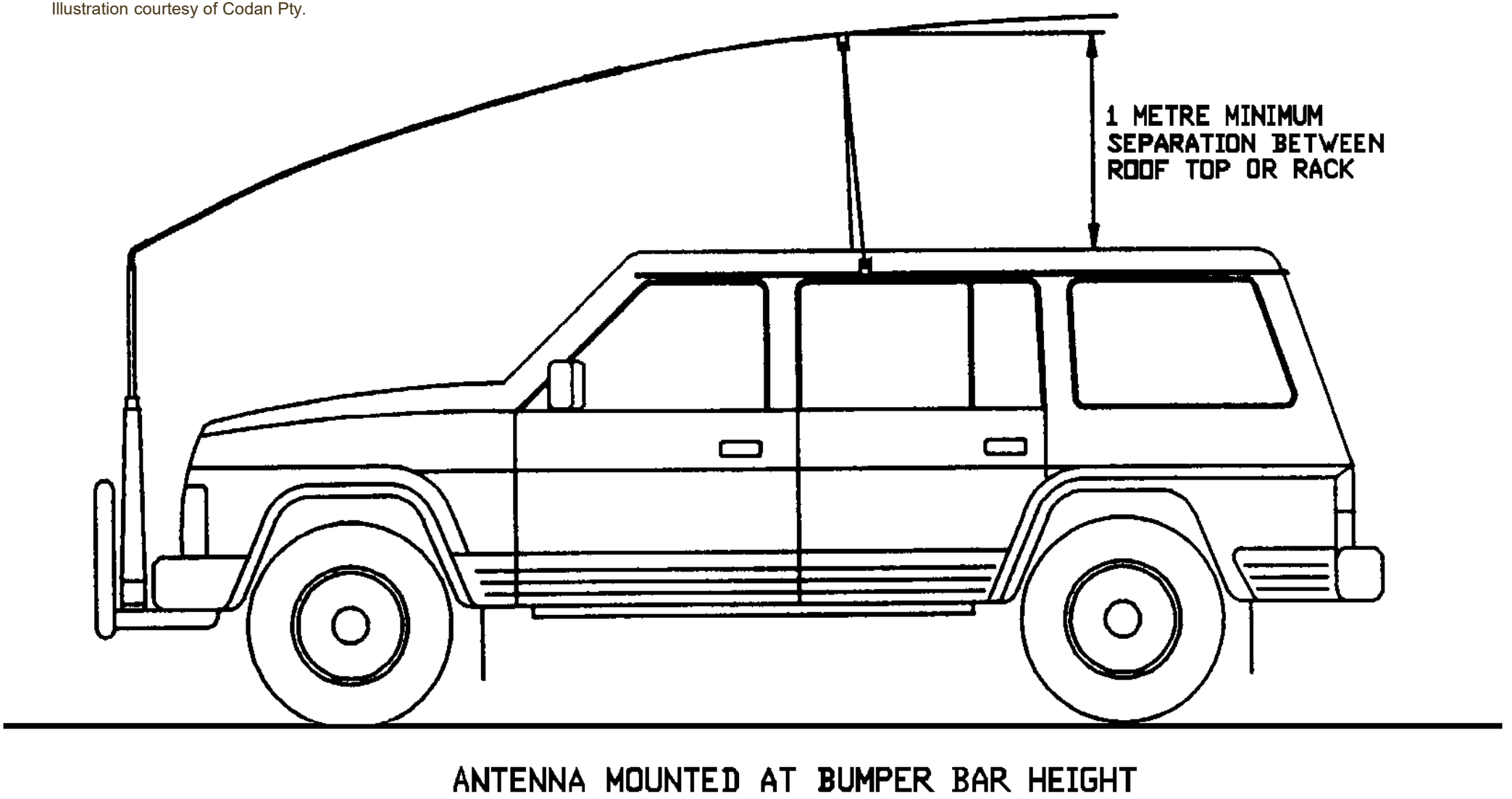
  Take care as high RF voltages exist on certain parts of these antennas

NVIS – Tilt Angle Adaptor

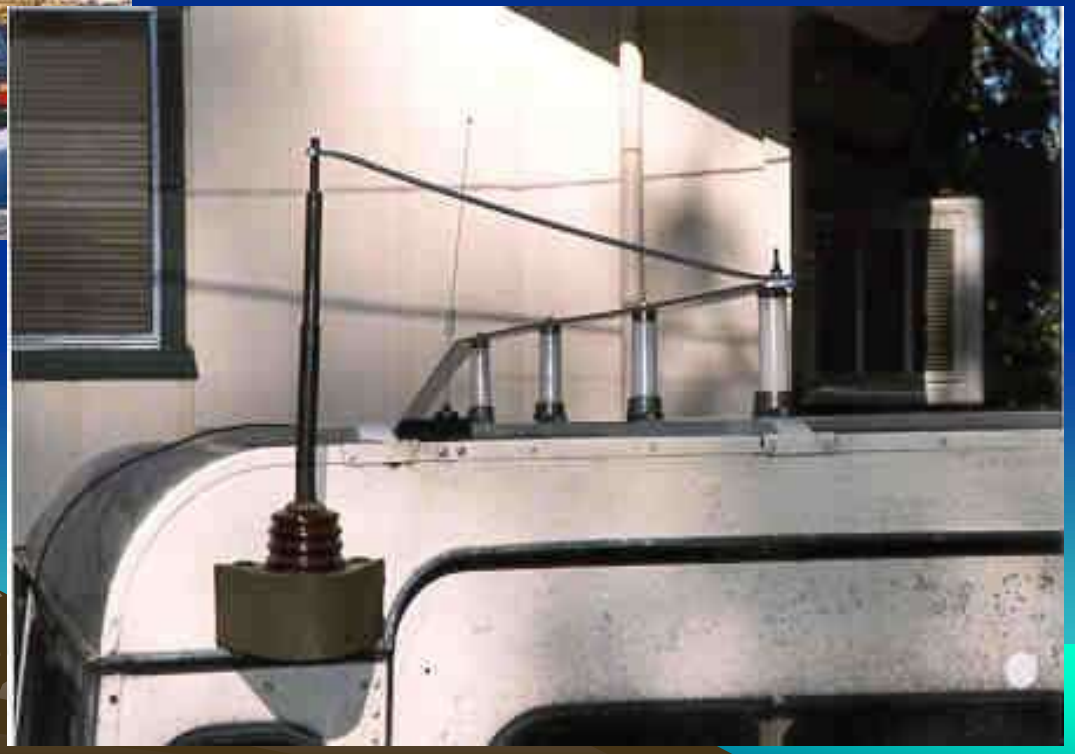
Illustration courtesy of NVIS Communication – W

NVIS – Codan's Whip Method

Illustration courtesy of Codan Pty.



NVIS – The Fore – Aft Loop (WA6UBE)



Photos courtesy of Patricia Gibbons, WA6UBE

NVIS – The Magnetic Loop (Russian Style !)

Photo PA3EQB

NVIS – The Magnetic Loop (Aussie Style !)

Photo Q-Mac Pty

NVIS – The Magnetic Loop (Redneck Style ?)

Photo WB3AKD

'Tone' Burst's View of NVIS

RSGB Radio Today Sept 2000

Use of Data Modes

- FT8, JS8, Multi-PSK,FLDigi, RTTY, AMTOR, PSK31, Olivia, etc. can be highly effective modes in NVIS Operations.
- Digital modes are highly effective at lower power and NVIS does not require high power for effective voice or data comms (Increasing signal security for military users). Power down to 100mW is effective and undetectable!
- Lower power (25 Watts phone) is needed for 250 SM NVIS coverage.
- Automatic Link Establishment (ALE) can be used as a FoF2 sampling method.

Useful websites connected with NVIS

- *http://umlcar.uml.edu/stationmap.html* Current Real-Time Ionogram stations for foF2 Critical Frequency
- *htt*https://www.sws.bom.gov.au/ Australian Space Weather agency. Several useful maps. Covers the World
- http://192.52.62.251/latestFrames.htm Millstone Hill Ionosonde
- http://car.uml.edu/common/DIDBFastStationList Worldwide Ionosonde Index
- hhttp://www.arrl.org/search/NVIS/page:1 The ARRL NVIS Resources
- http://www.fracassi.net/iw2ntf/manuali/Homebrew%20AS-2259GR%20NVIS%20Antenna.pdf Homebrew AS-2259 NVIS ANT
- http://arrl-ohio.org/SEC/nvis/Modified%20AS-2259%20NVIS%20Antenna.pdf Another Homebrew NVIS Site
- https://youtu.be/yYXVKtu3nwk "Let's build a NVIS Antenna Video"
- https://youtu.be/MncDlhdBOlY "The HF Renaissance in the US Army" on YouTube

Useful Websites Cont.

- http://www.bushcomm.com.au/ Bushmaster ALE and NVIS antennas
- https://www.hilomast.com/antenna-systems/ Mobile NVIS Loop Antenna source
- https://www.hiqantennas.com Hi-Q NVIS Antennas
- http://www.qsl.net/wb5ude/nvis A NVIS information site
- http://www.hawaiiares.info/current_propagation.shtml Hawaii ARES/NVIS site
- http://www.arrl.org/news/ohio-ares-nvis-antenna-day-concludes-that-the-truth-is-up-there QST article on Ohio ARES/NVIS operations
- http://hflink.com/ The Ham HF ALE Website
- http://kv5r.com/ham-radio/nvis-army-fm-24-18/ US Army NVIS Field Manual

NVIS - Summary

- NVIS offers less footprint to Direction Finding (military users!)
- NVIS is undergoing a renaissance in the U.S. Military!
- Covers 0 – 250 SM using High-Angle (60-90°) Skywave
- Choice of Correct Frequency Band just below the Critical Frequency is most important.
- Antenna must be horizontal, not vertical (with the exception of magnetic loops)
- Antenna must be low – between 0.25 and 0.10 of a wavelength above ground'
- Multiband antenna (at least three bands) needed for 24hr NVIS coverage

NVIS - The End