



Near Vertical Incident Skywave Propagation

09/18/2025

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A.C.S.

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Near Vertical Incident Skywave Propagation Agenda



- Propagation Basics
- Skip Zone Problem
- NVIS Solutions

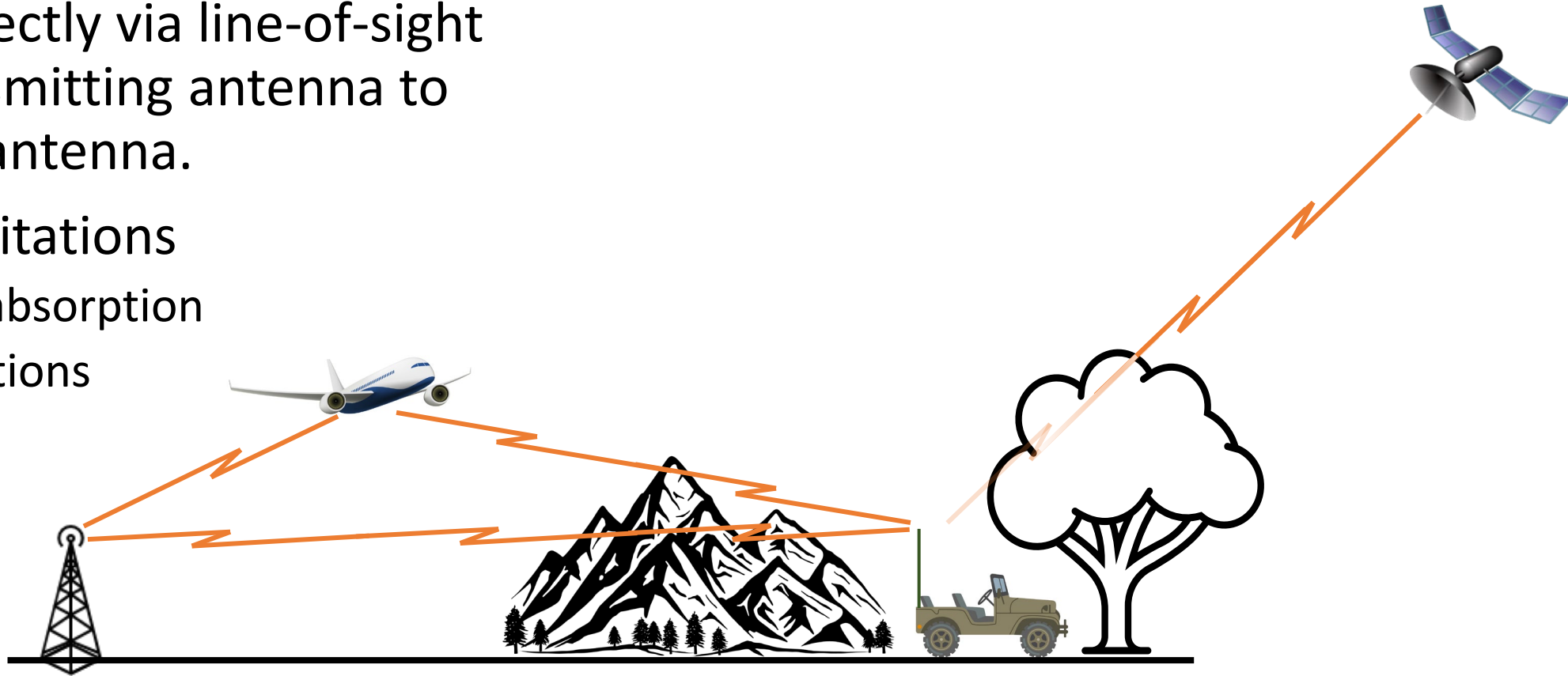


Propagation

Direct Wave Mode



- Component of wave front that travels directly via line-of-sight from transmitting antenna to receiving antenna.
- Range Limitations
 - Terrain absorption
 - Obstructions

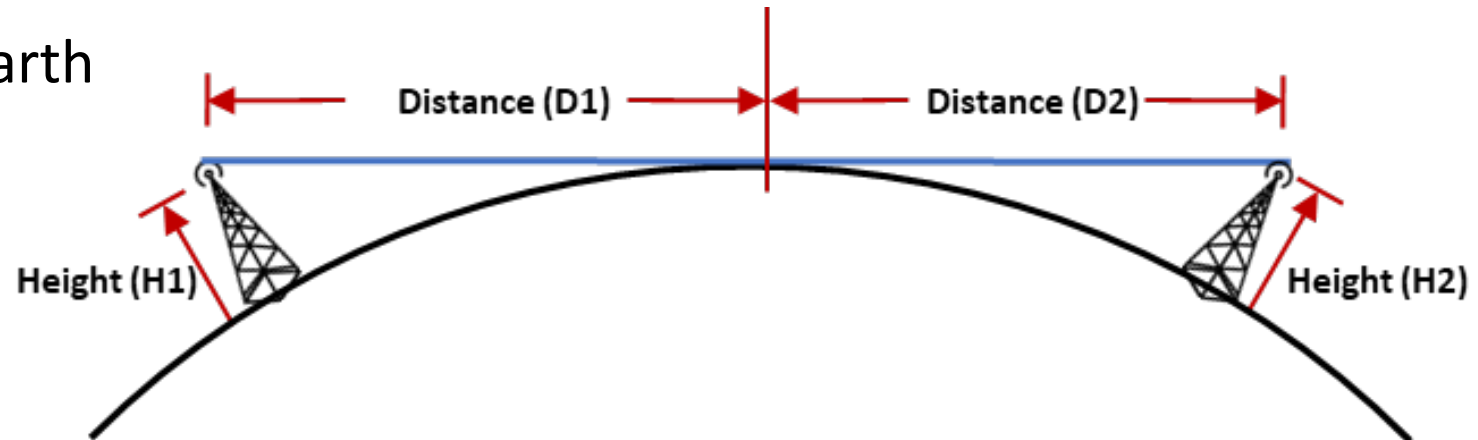




Propagation

Direct Wave Mode

- Component of wave front that travels directly via line-of-sight from transmitting antenna to receiving antenna.
- Range Limitations
 - Terrain absorption
 - Obstructions
 - Curvature of earth

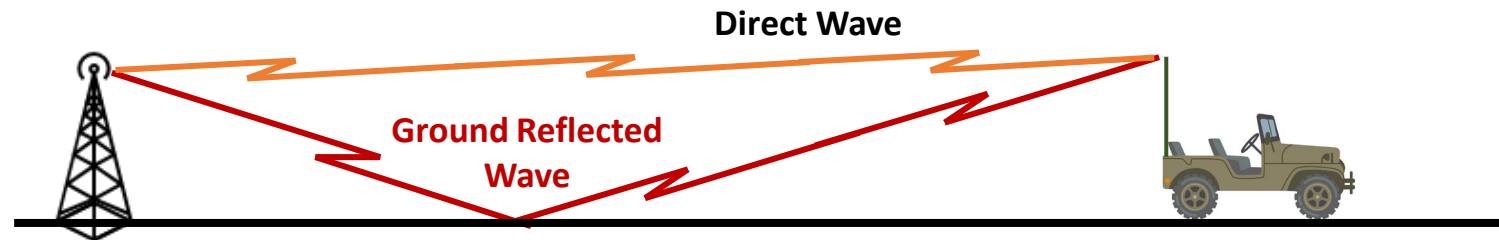




Propagation

Ground Reflected Wave Mode

- Component of the radiated wave that reaches the receiver after being reflected from the ground.
- Ground Reflected Wave travels longer distance than direct wave.
 - Can result in interference at receiver



Combined Direct Wave and Ground Reflected Wave defined as **SPACE WAVE**

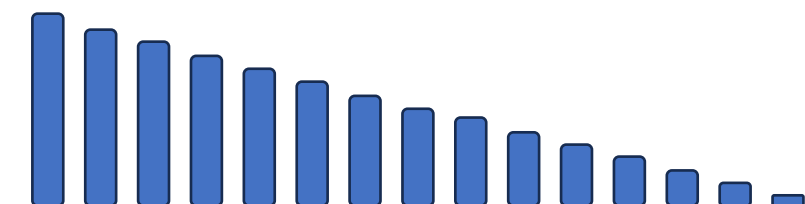


Propagation

Surface Wave Mode

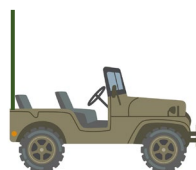
- Component of the wave front that travels along the earth's surface.
- Impacted by conductivity and dielectric constant of the earth.
- Range varies widely
 - 2-Miles – Beyond line of Sight

- Energy in wave absorbed by the earth
 - Energy loss increases with frequency
- Vertically Polarized antennas work best



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Signal Strength



ARRL Antenna Book

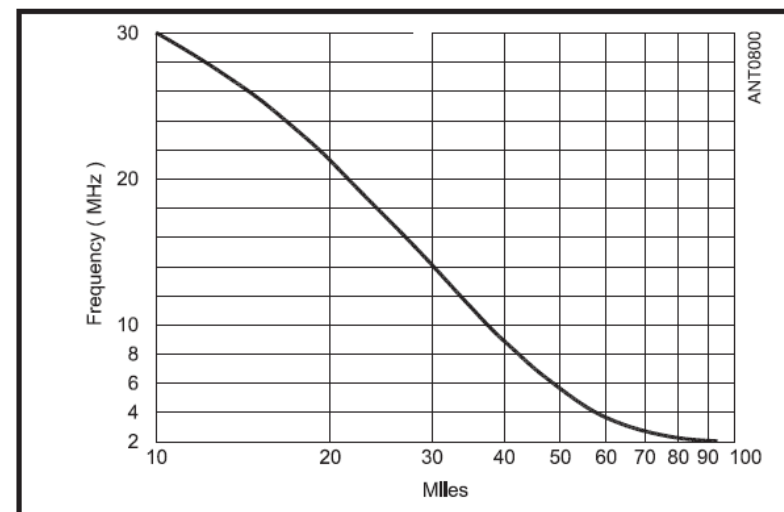


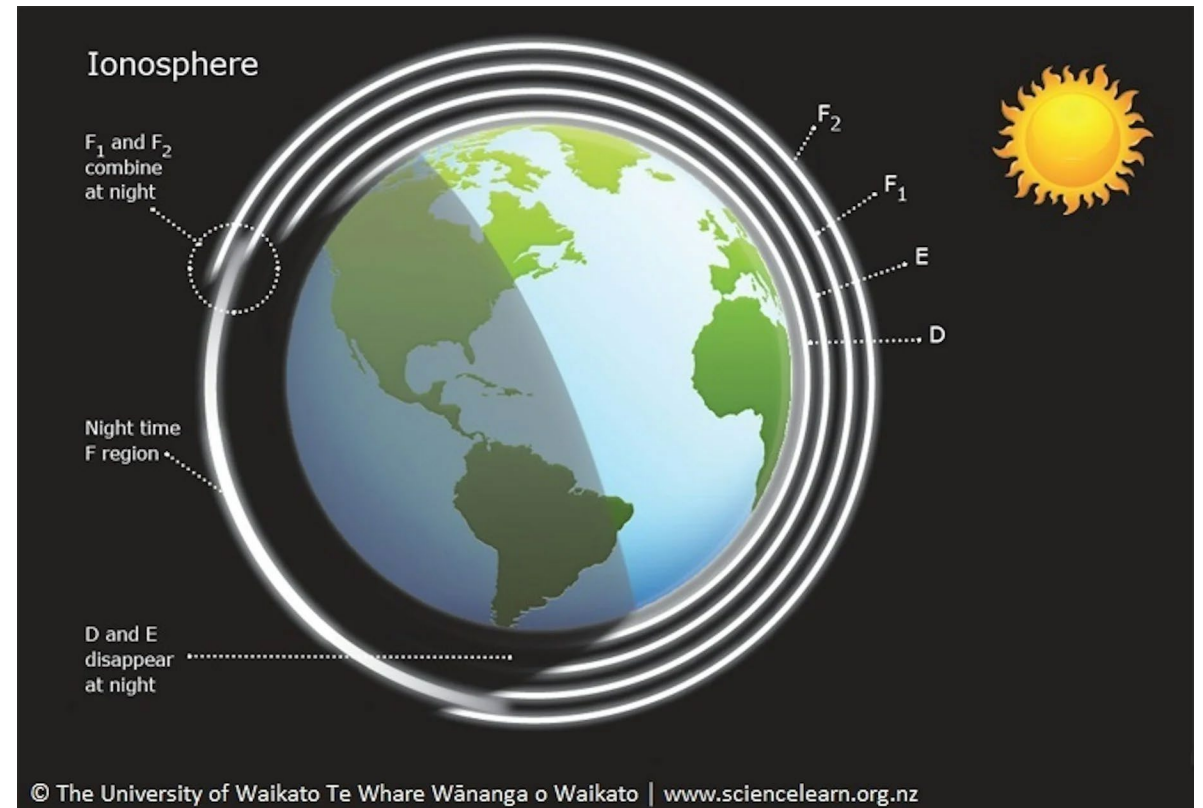
Figure 4.1 — Typical HF ground-wave range as a function of frequency.



Propagation Skywave Mode



- Radio Transmissions that make use of the ionospheric Refraction (Bending)
- More Refraction
 - High Ionization
 - Lower Frequency

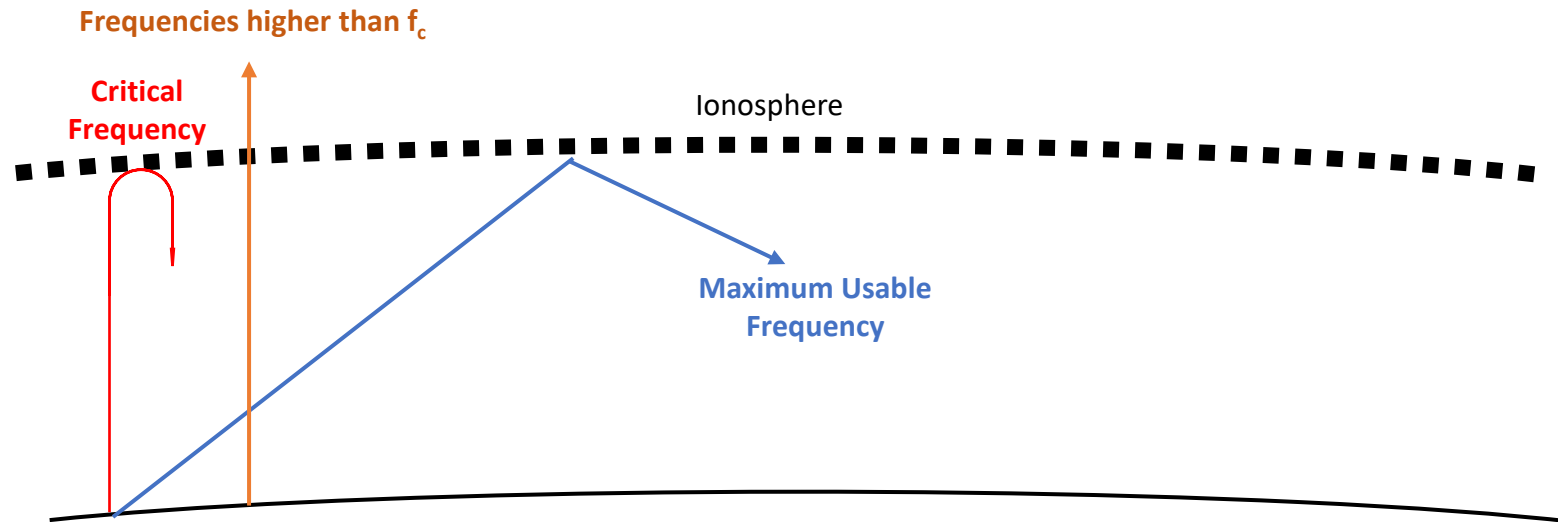




Propagation Skywave Mode



- **Critical Frequency (f_c)** is the highest frequency signal that can be transmitted straight up and be reflected back to earth
- **Maximum Usable Frequency (MUF)** is the highest frequency that can be used for transmission between two points
 - Predicted – 50% of the days in a month

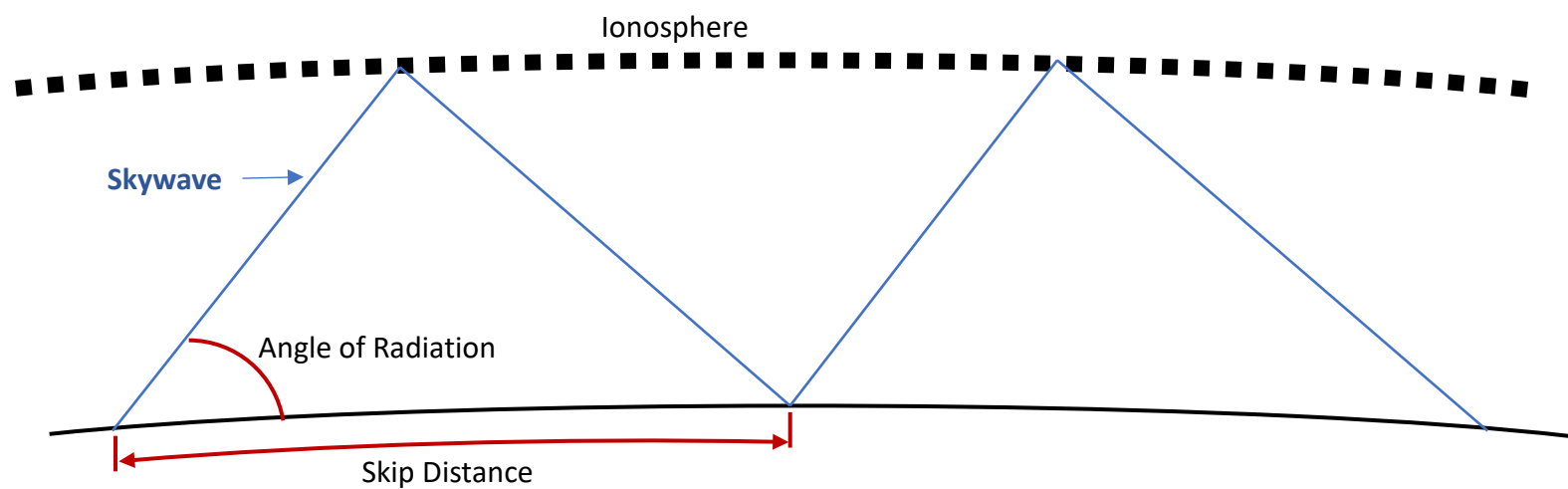




Propagation Skywave Mode



- Radio Transmissions that make use of the ionospheric Refraction (Bending)
- Skip Distance
 - Angle of Radiation
 - Frequency
 - Degree of Ionization





Near Vertical Incident Skywave Propagation Agenda



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Skip Zone Problem Vertical Antenna



- Vertically polarized Antenna
- Elevation Plot (EZNEC)

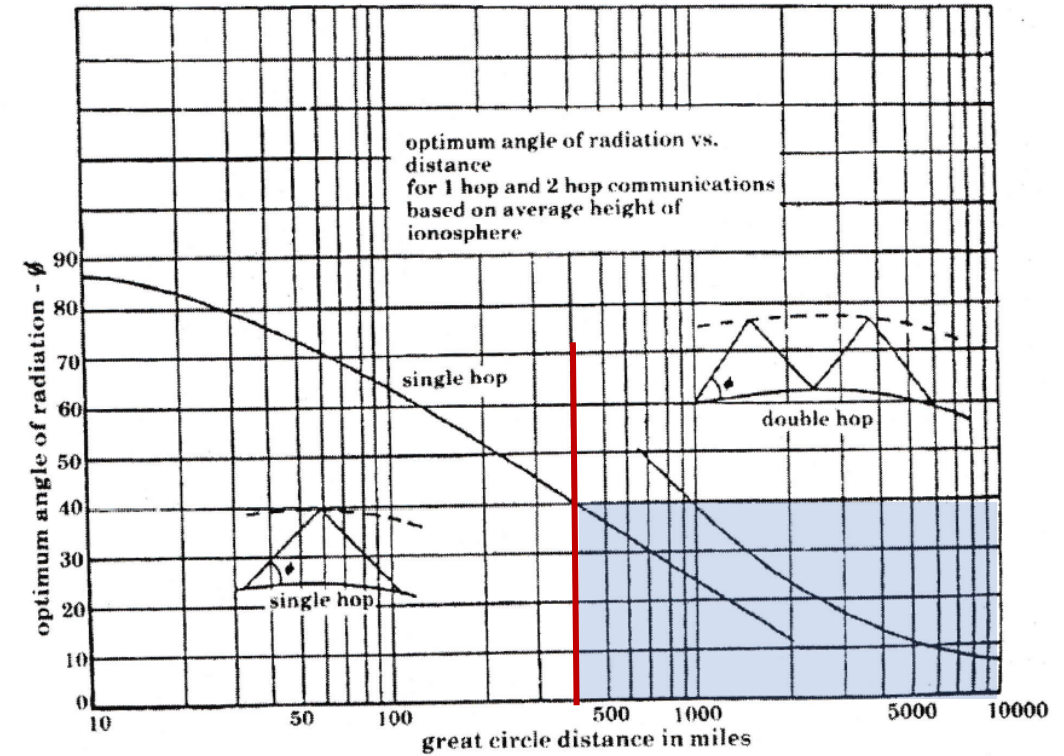
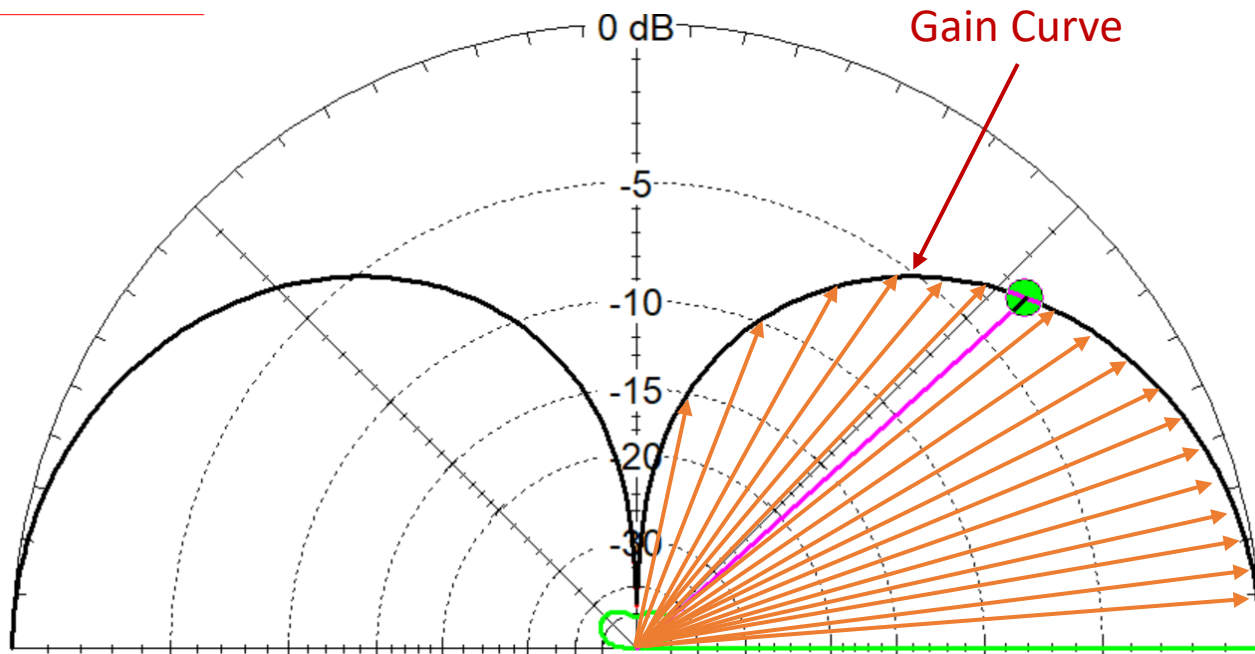


Figure 2. Radiation angle vs. range (from The Rules of the Antenna Game).

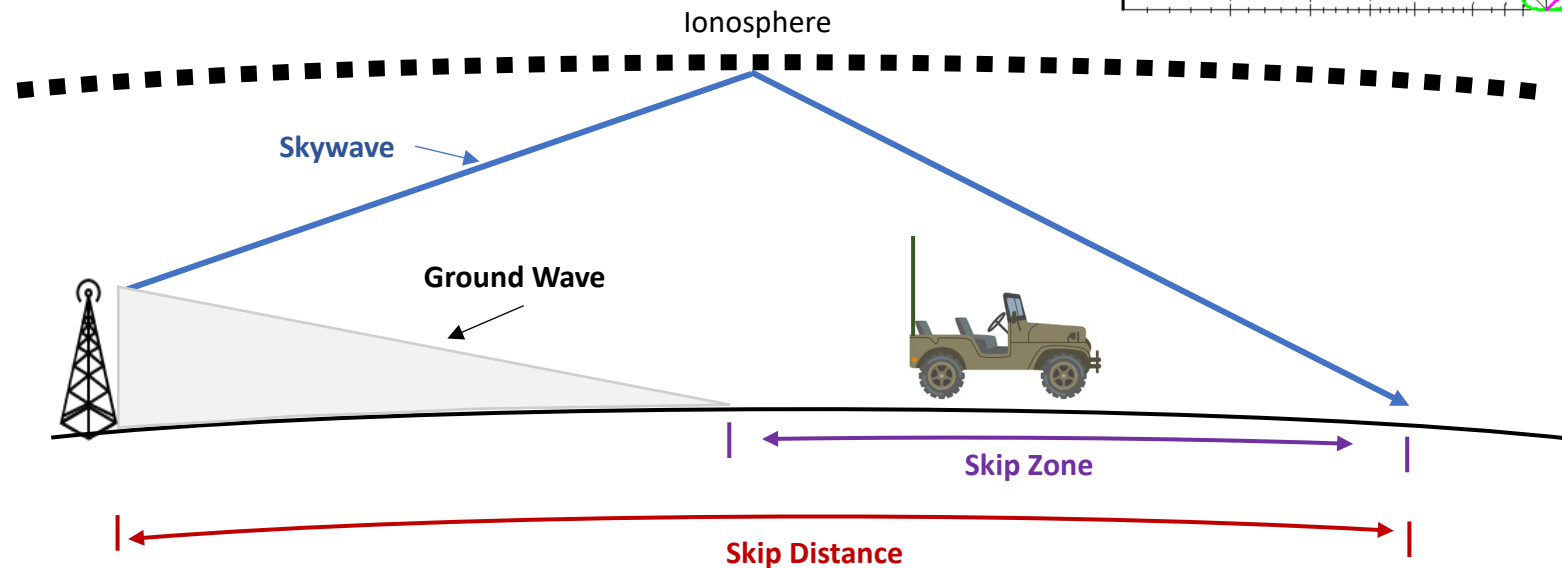
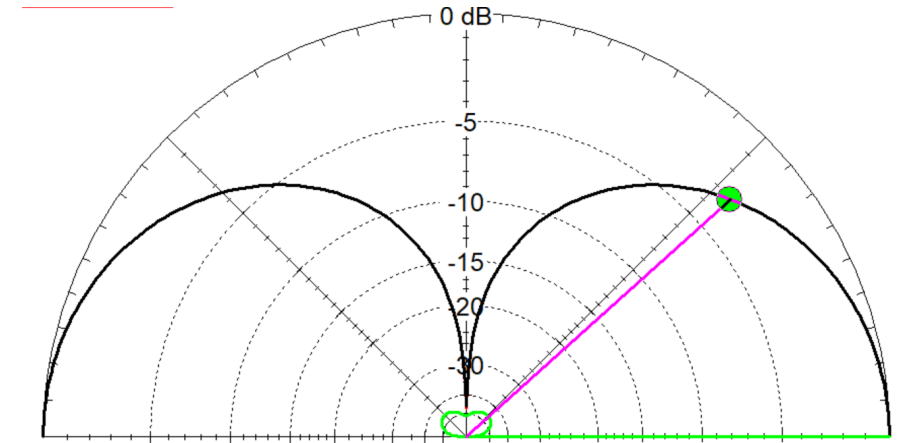


Skip Zone Problem

Vertical Antenna



- Vertically polarized Antenna
- Lower angles of radiation create skip Zones





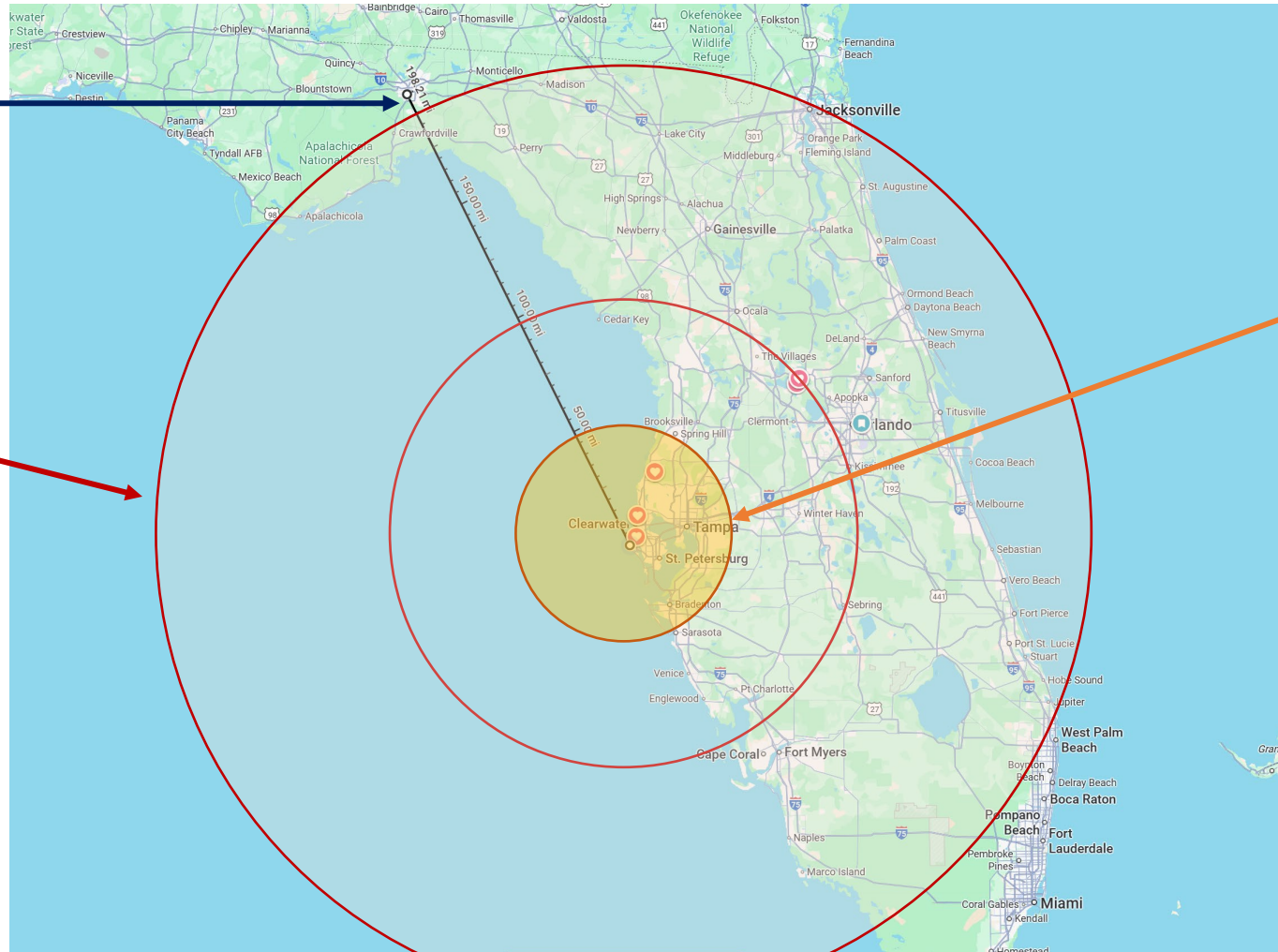
Propagation

Skip Zone Problem – State of Florida EOC

State of Florida EOC
Range – 200 mi

Skip Zone

Ground Wave





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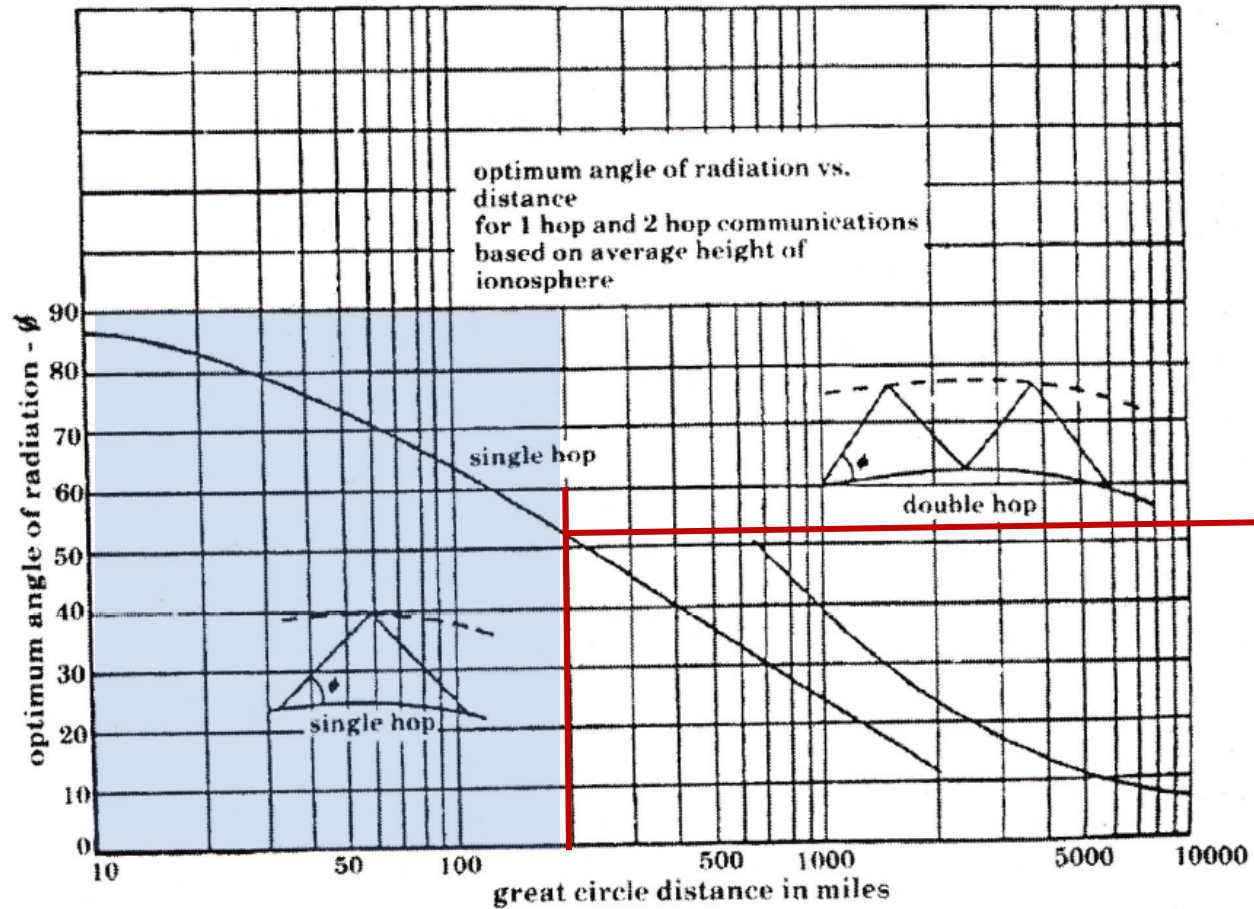


NVIS Solutions

Skip Zone Problem



State of Florida EOC
Range – 200 mi



Approximately 52 Degrees

Figure 2. Radiation angle vs. range (from The Rules of the Antenna Game).

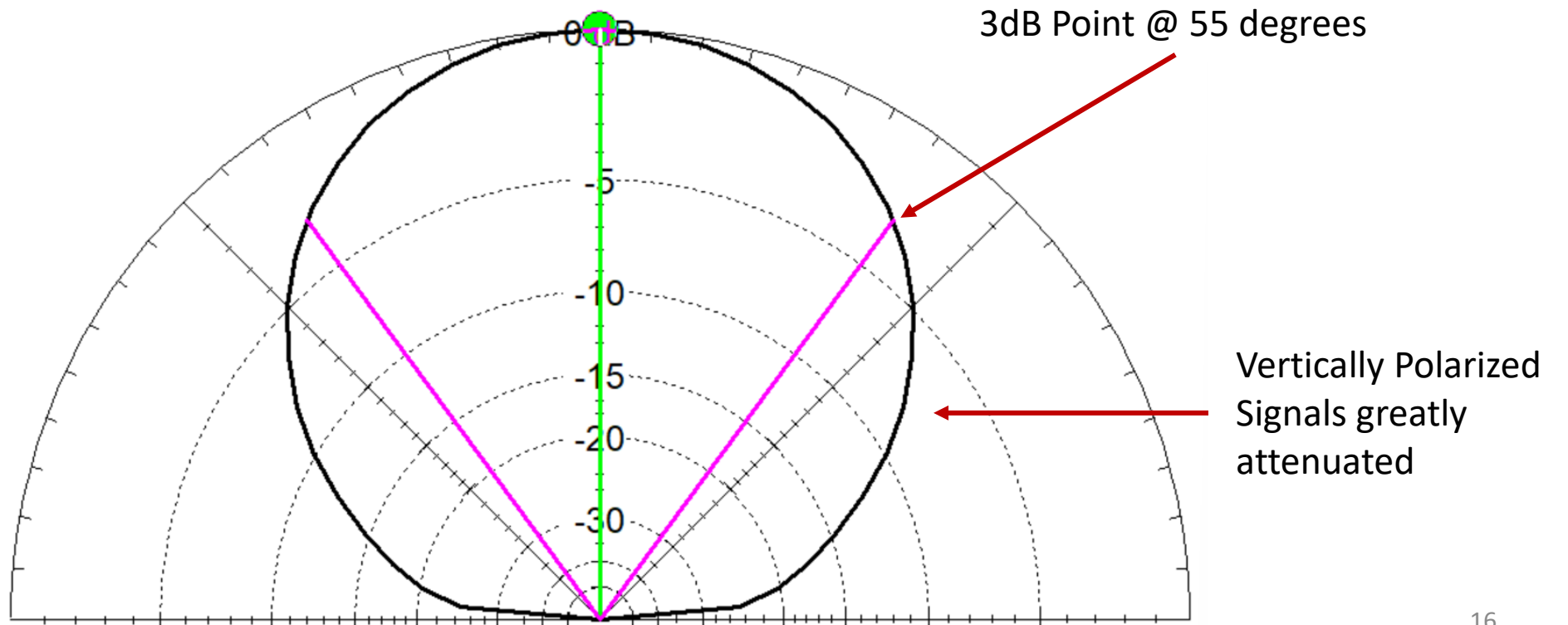


NVIS Solutions

Skip Zone Problem



- Create / Use Antenna that creates a high angle of radiation
- Use a frequency below the Critical Frequency (f_c)

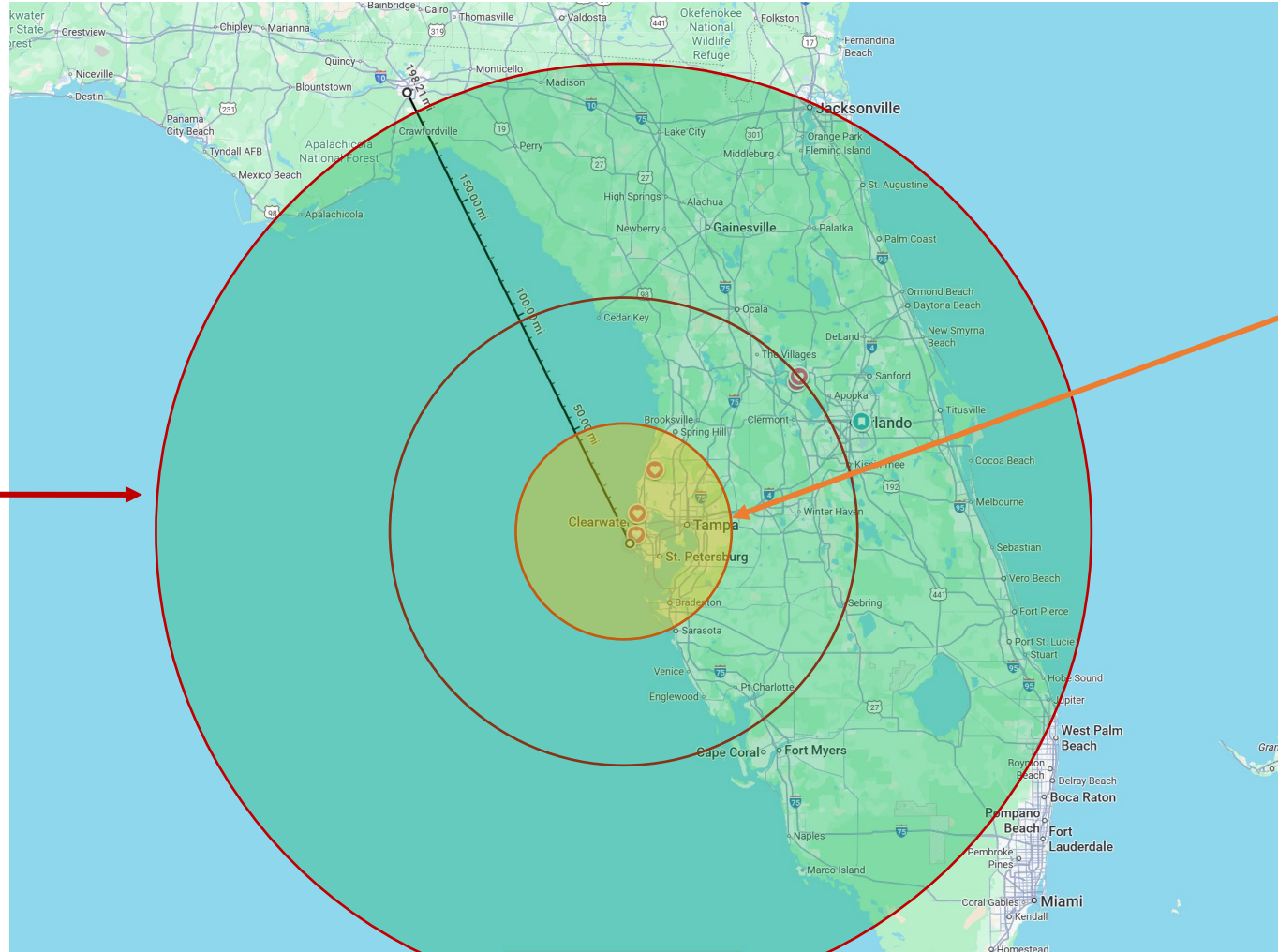




NVIS Solutions

Skip Zone Problem – State of Florida EOC

**NVIS
Coverage
Area**



Ground Wave



NVIS Solutions

Antenna design



- Use Horizontally Polarized Antennas
- Keep antenna height below 0.25 wavelength

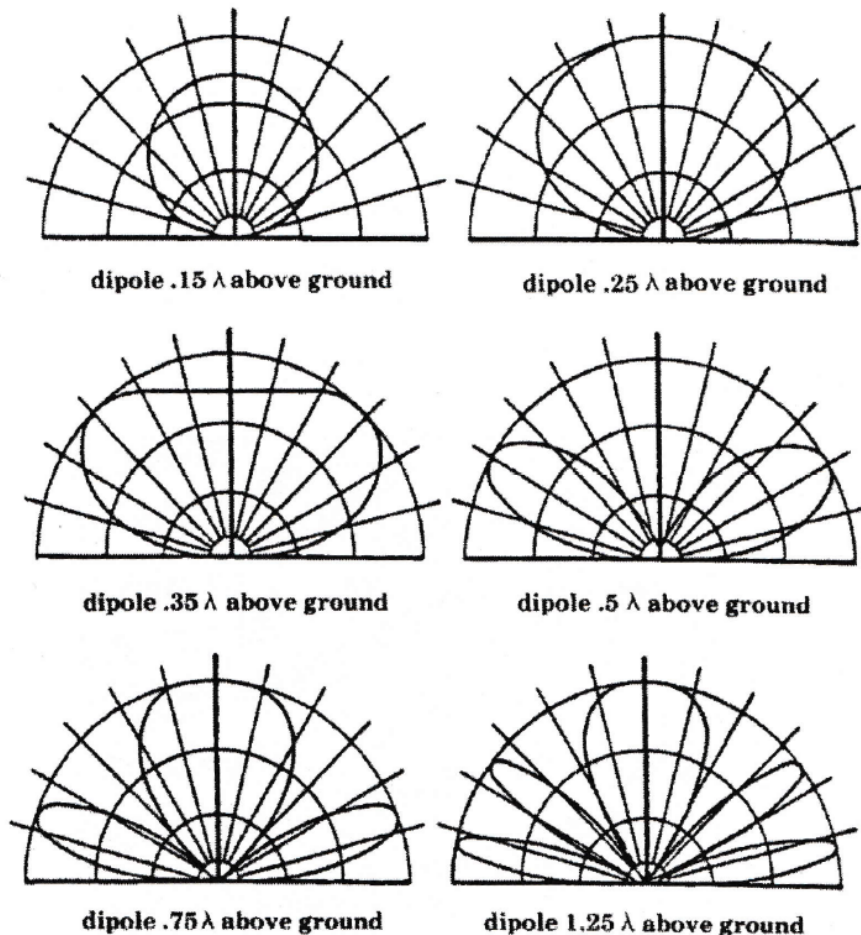
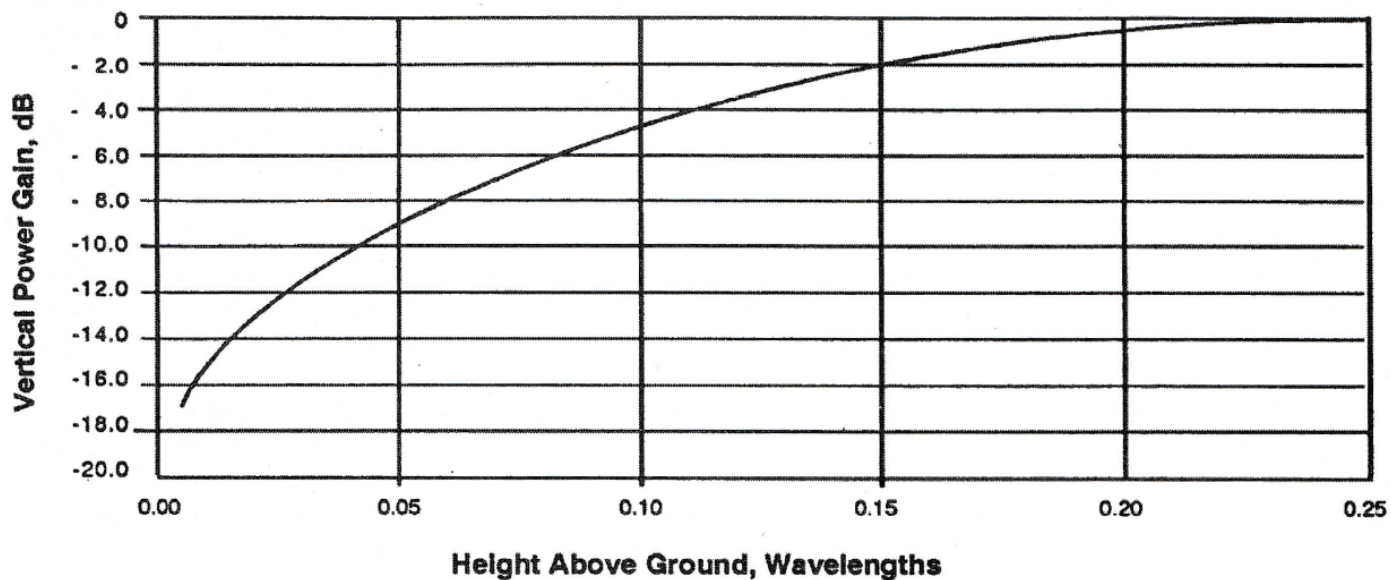


Figure 3. Horizontal dipole radiation patterns at various heights (in wavelengths) above the ground (from Air Force Comm. Pam. 100-16).



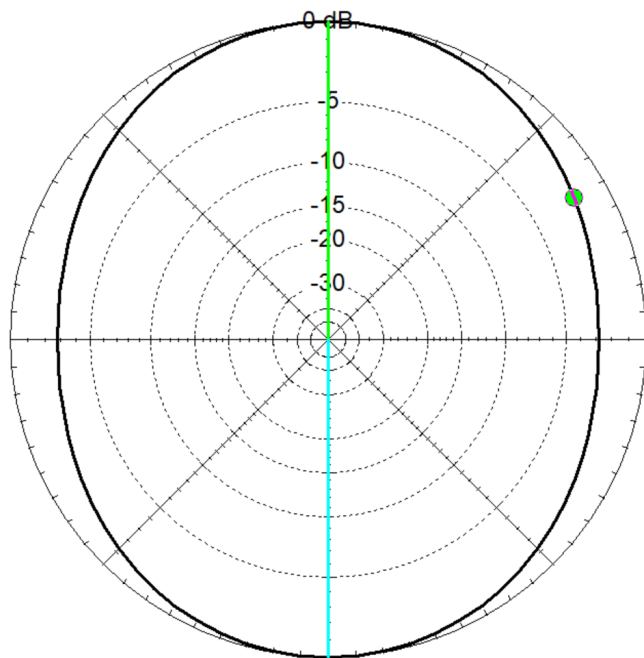
NVIS Solutions

Antenna design - Dipoles

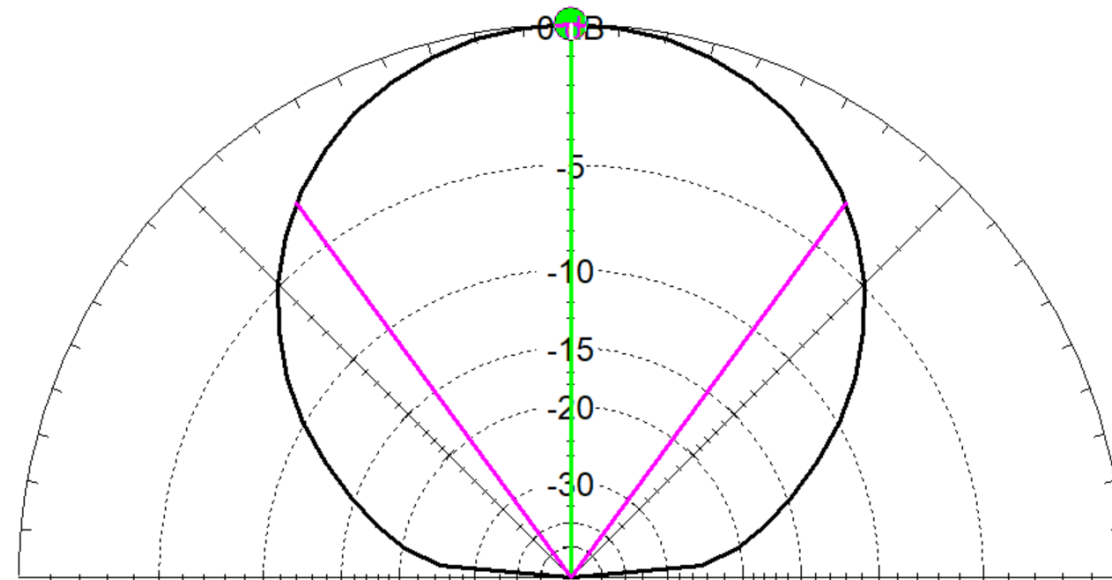


- Advantages
 - Good Gain
 - Omnidirectional

- Disadvantages
 - Narrow Bandwidth



Azimuth Plot

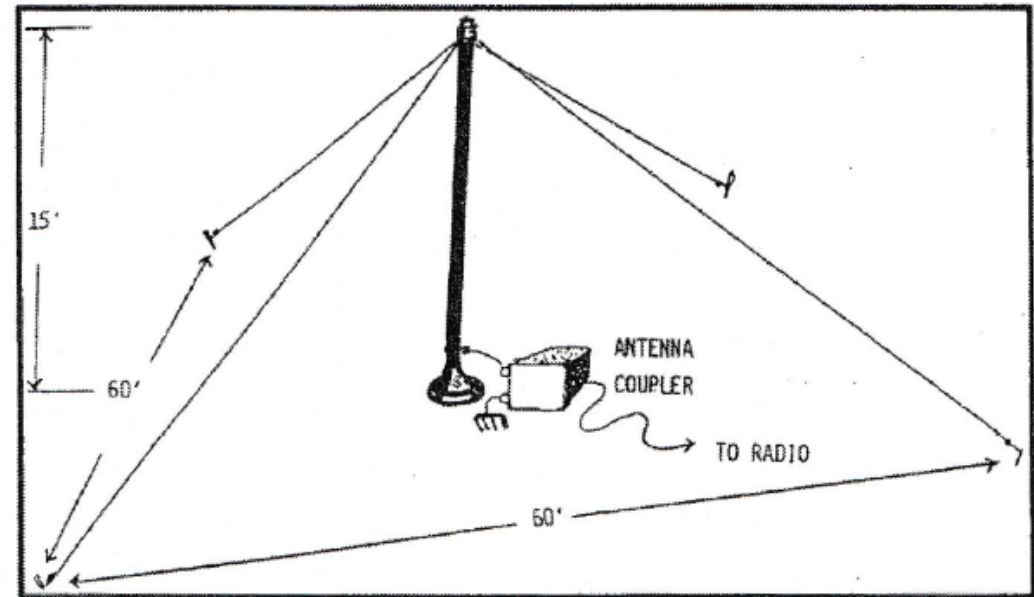
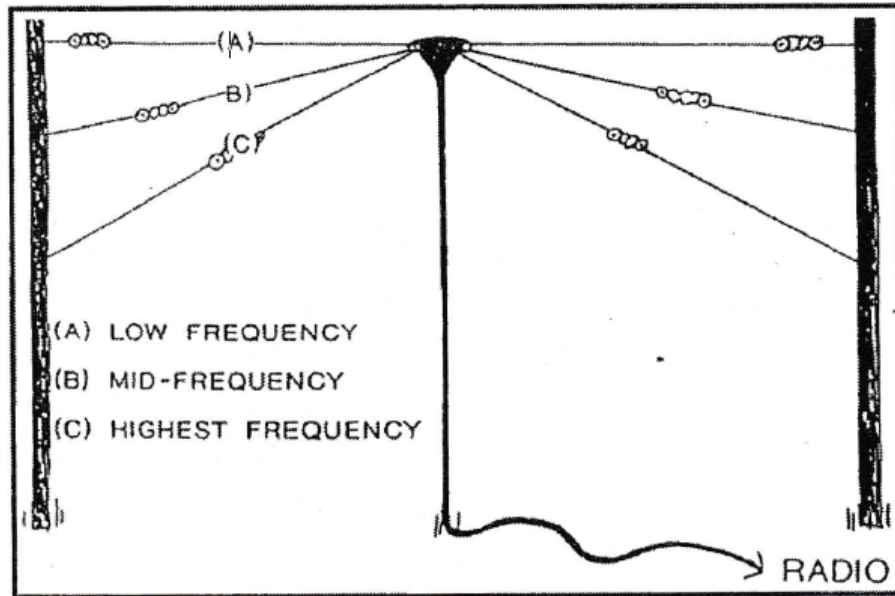


Elevation Plot



NVIS Solutions

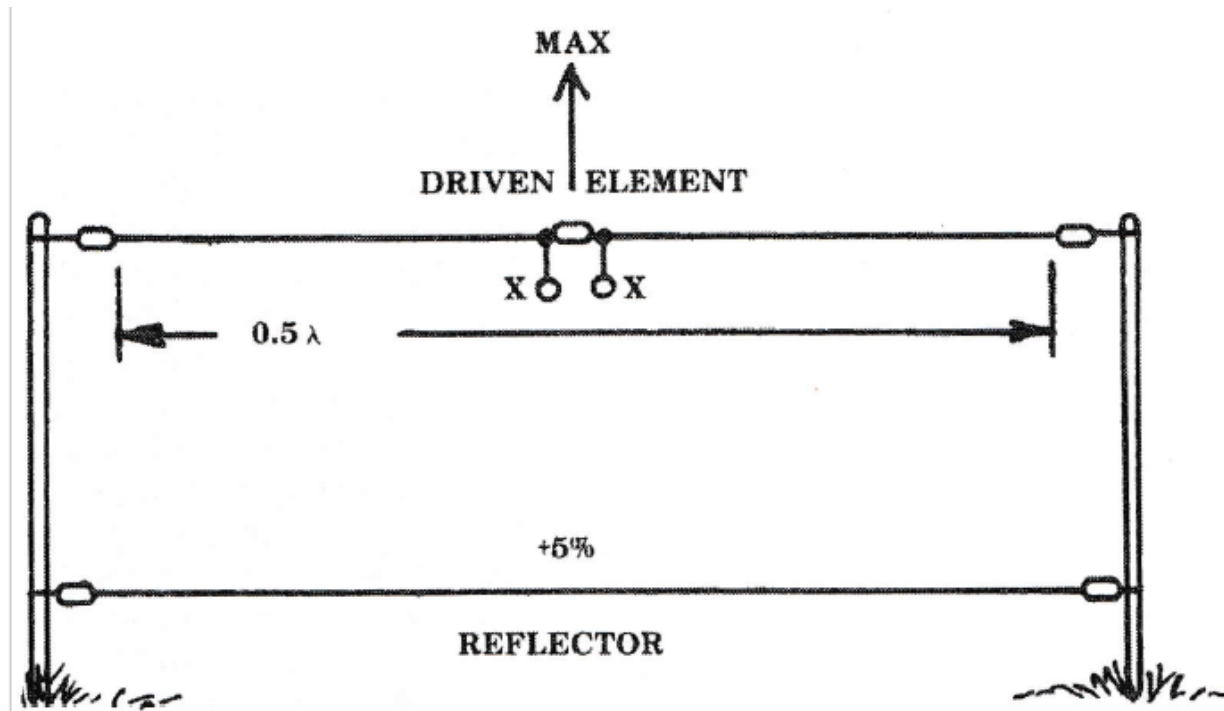
Antenna design – Multi-Band Dipoles





NVIS Solutions

Antenna design –Dipole with Reflector

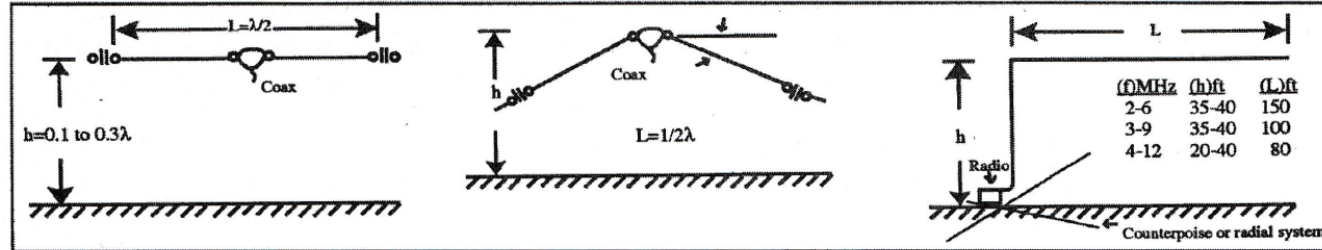


Half wavelength dipole with reflector



NVIS Solutions

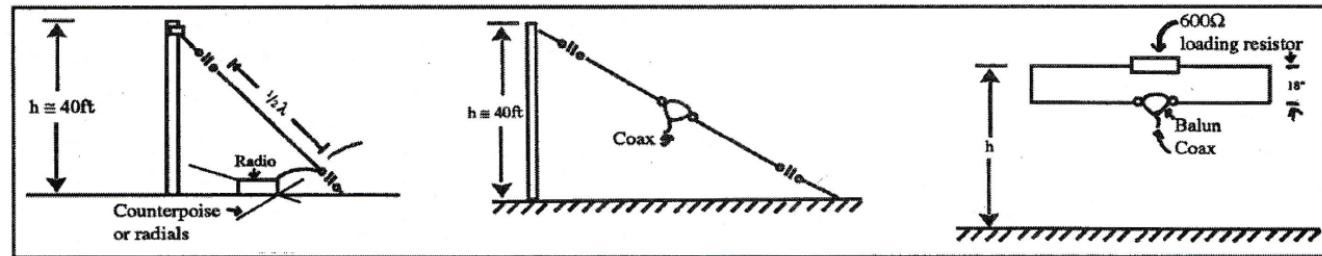
Antenna design



a. Half-wave Dipole

b. Inverted V

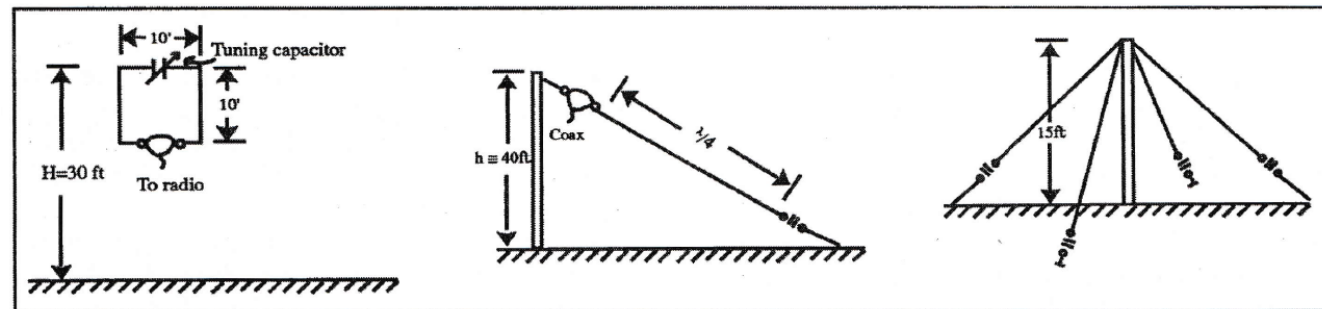
c. Inverted L



d. Sloping Wire

e. Inclined Dipole

f. T2FD



g. Small Loop

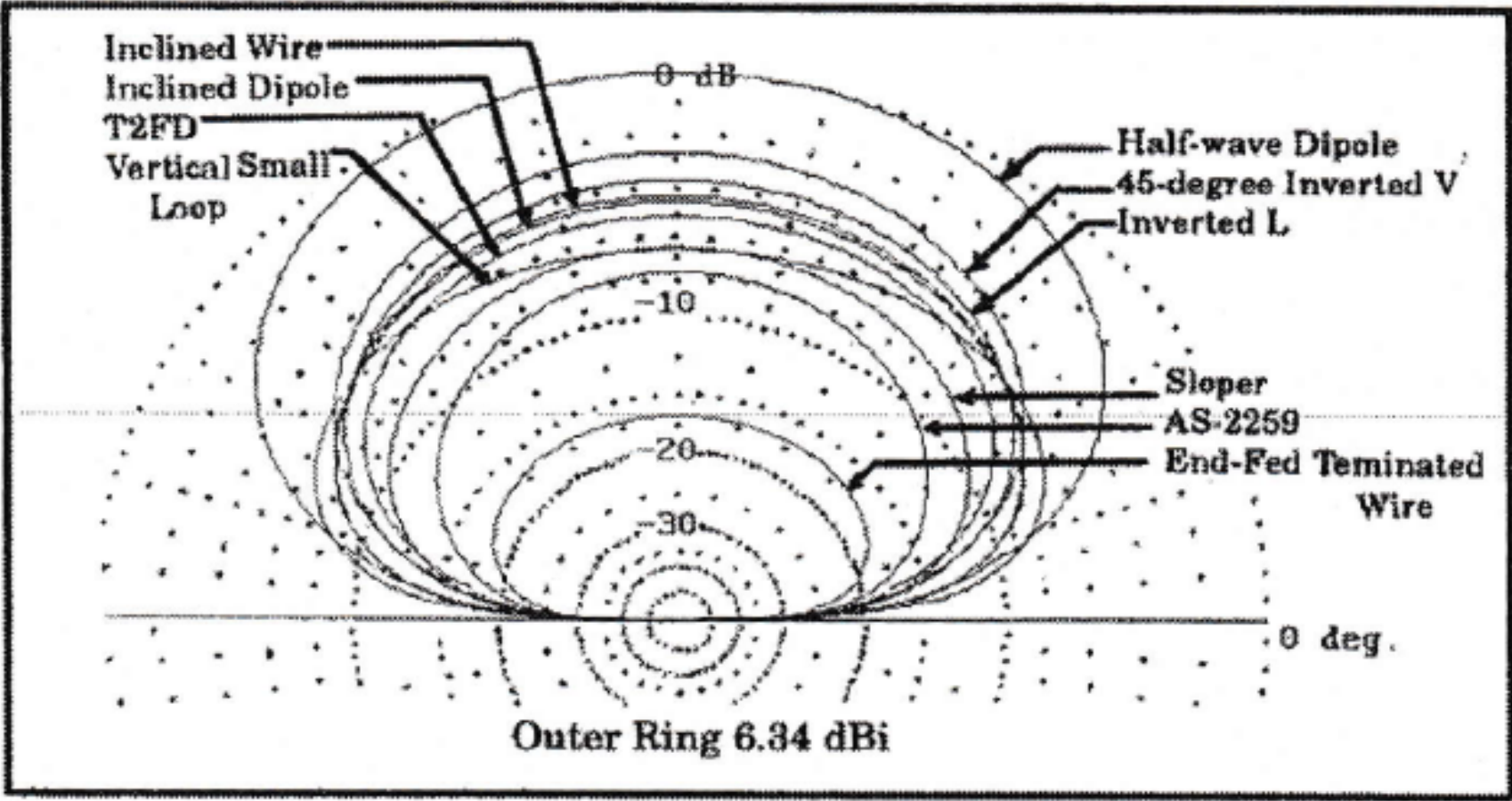
h. Sloper

i. AS-2259



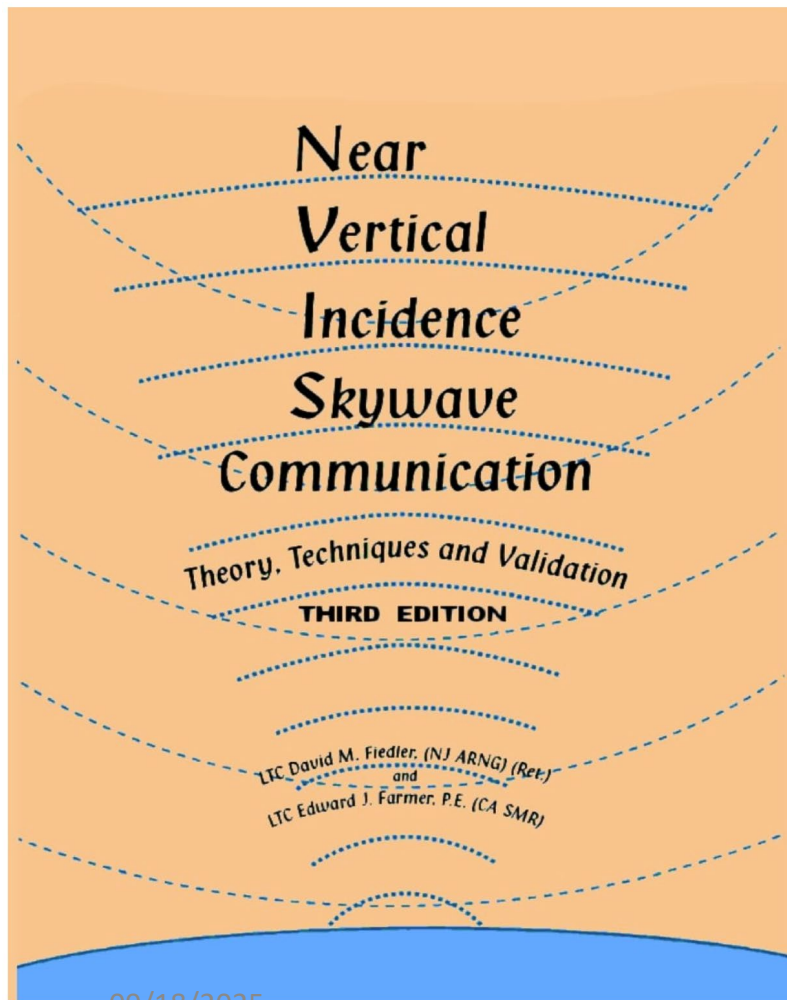
NVIS Solutions

Antenna design





NVIS Conclusion



- Excellent Source for information on NVIS theory and antenna design



Back-up