Emergency Antennas

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Without the antennas….nothing goes anywhere!

What we will cover

- Propagation! ***The magic sauce of ham radio since we were "banished" below 200 meters!***
- Field Expedient Antennas
  - HF
  - VHF/UHF
- RF Exposure Compliance
- Live Demo

Propagation

Isn't it amazing that we can put a few watts into a piece of WIRE and create an easily discernible electric/magnetic FIELD in Tokyo, Japan??

Electromagnetic field have only a few basic techniques to go from point A to point B:

1) Point to Point (direct line of sight)

2) Ground Wave

3) Ionospheric Refraction

   - "NVIS"

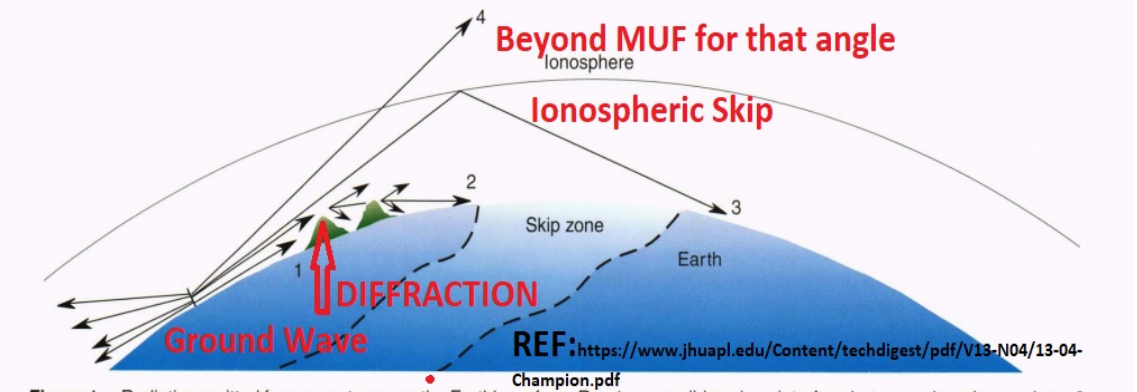


Figure 1. Radiation emitted from an antenna on the Earth's surface. Ray 1, wave glides along interface between air and ground; ray 2, wave travels directly to distant mountain and diffracts from mountain peak; ray 3, wave travels into sky, interacts with ionosphere, and reflects back to a distant point; ray 4, wave passes through the ionosphere and into space. No wave is present in the skip zone.

Line of Sight

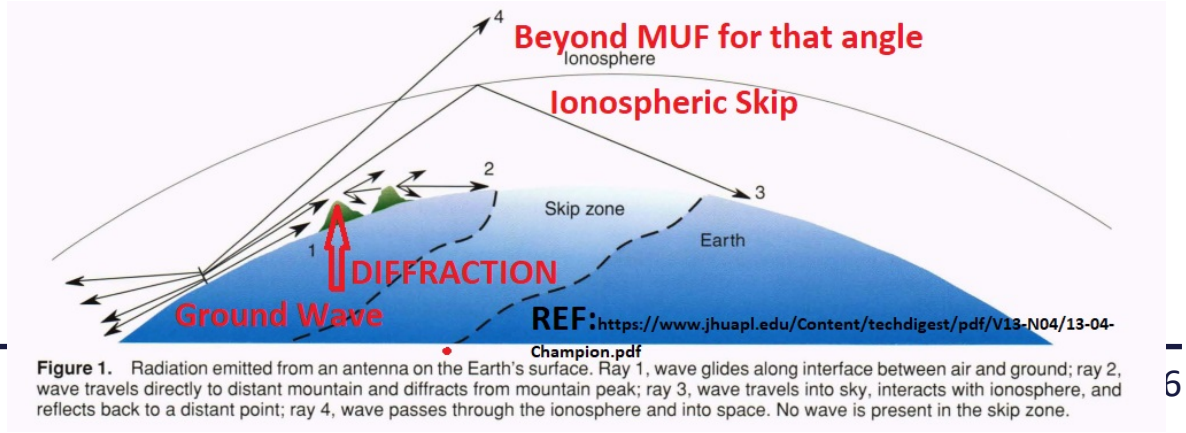
Electromagnetic field can be considered to fill a “fresnel” zone (football shape) between sender and receiver.

- Attenuation of AIR is very very low (basically just “spreading” of energy over the volume of an expanding sphere)
- **DIRT has very high attenuation**….waves don’t do well thru hills/mountains
- At VHF/UHF, BUILDINGS aren’t much better….
  - *We measured 26dB per MILE at UHF frequencies in one Florida Baptist Disaster Relief test: 2-3 miles range!*
- Knife-edge diffraction can get you over a bit of a hill….if the geometry is right.
- RadioMobile Online can help you plan coverage
- At VHF/UHF: **HEIGHT IS MIGHT!** Square root of antenna height(feet) + 20% = BEST CASE VHF Range before diving into dirt due to curvature of earth.

Ground Wave

Highly **over-rated in poor soil land like Florida**…..we never get more than a few miles even on 80 meters….maybe 10 miles??

- Likely works MUCH BETTER over sea-water, possibly over better soil….
- Better with VERTICAL ANTENNAS
- Drops by the SQUARE as you go up in frequency
- Interesting European experiment on arrival of waves….



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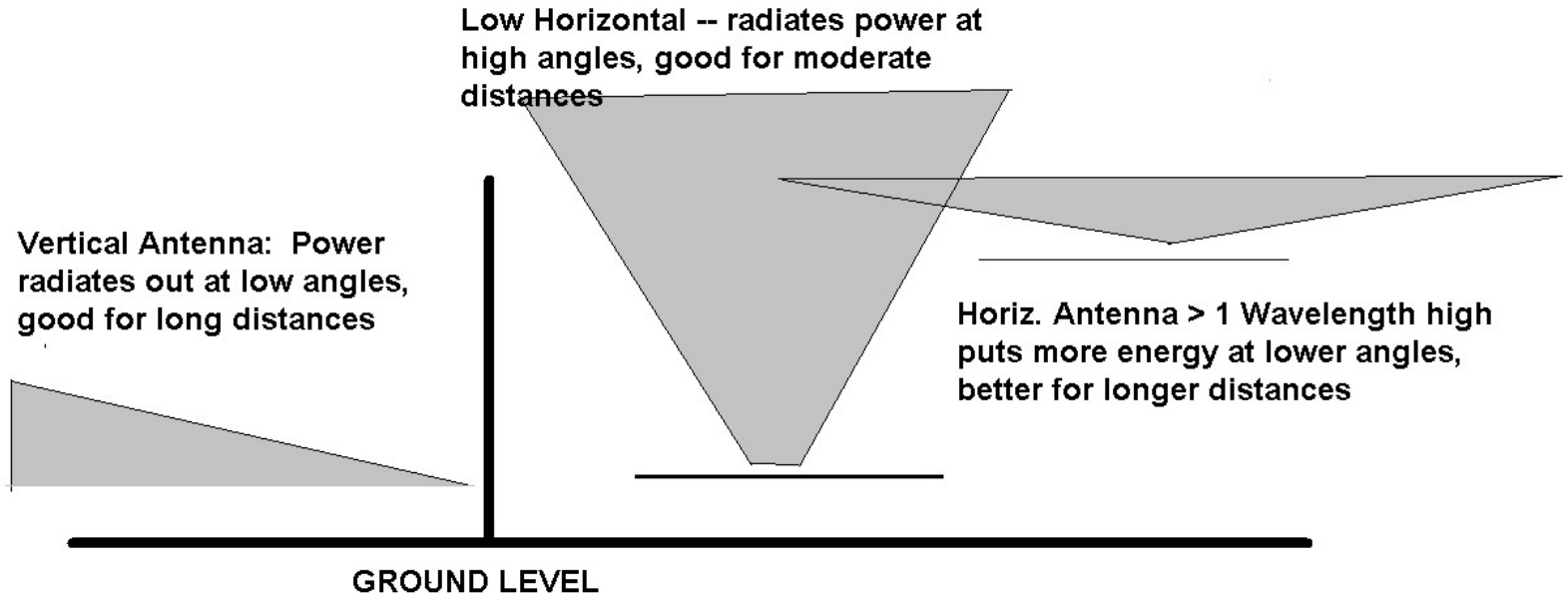
Types of Antennas



Ionospheric Refraction

What set amateur radio apart in the beginning...the ability to jump THOUSANDS of miles with relatively low power between 3-30 MHz.

To best exploit skywave, need to understand a few concepts

- Glancing waves easier for the ionosphere to bend
- Lower frequency waves easier for ionosphere to bend
- Bending capability depends on high-energy radiation from the SUN
  - Bending capability higher during day / sunspots
  - Bending capability lower at night

“Glancing waves easier to refract”

Your comms goal and your antenna type need to be in sync!

- The less bending required, the easier to have success – so low-angle waves easier to refract – AND GO FARTHER DUE TO GEOMETRY
  - Think VERTICAL ANTENNAS
  - Think VERY HIGH HORIZONTAL DIPOLES
  - Think GREAT FOR WorkIng DX….not so good for reaching your state capitol EOC
- Refracting 180 degrees THE HARDEST OF ALL….but REQUIRED to get to the other side of your own city….”Near Vertical Incidence Sky Wave”

Think HORIZONTAL ANTENNA at relatively low height

“Lower Frequency waves easier to refract”

Your understanding of frequency will make your success more likely

- The higher the frequency the harder to refract….AT ALL! That’s why UHF / Microwave is used for space communications….passes right thru ionosphere
- Bending nearly 180 degrees hardest of all….so only the LOWEST frequencies can be NVIS
- “Critical Frequency” – highest frequency that can be bent 180 degrees
  - Measured every 15 minues by radio-ionosondes operated by government
  - Data READILY available.

Ionospheric Bending Capability

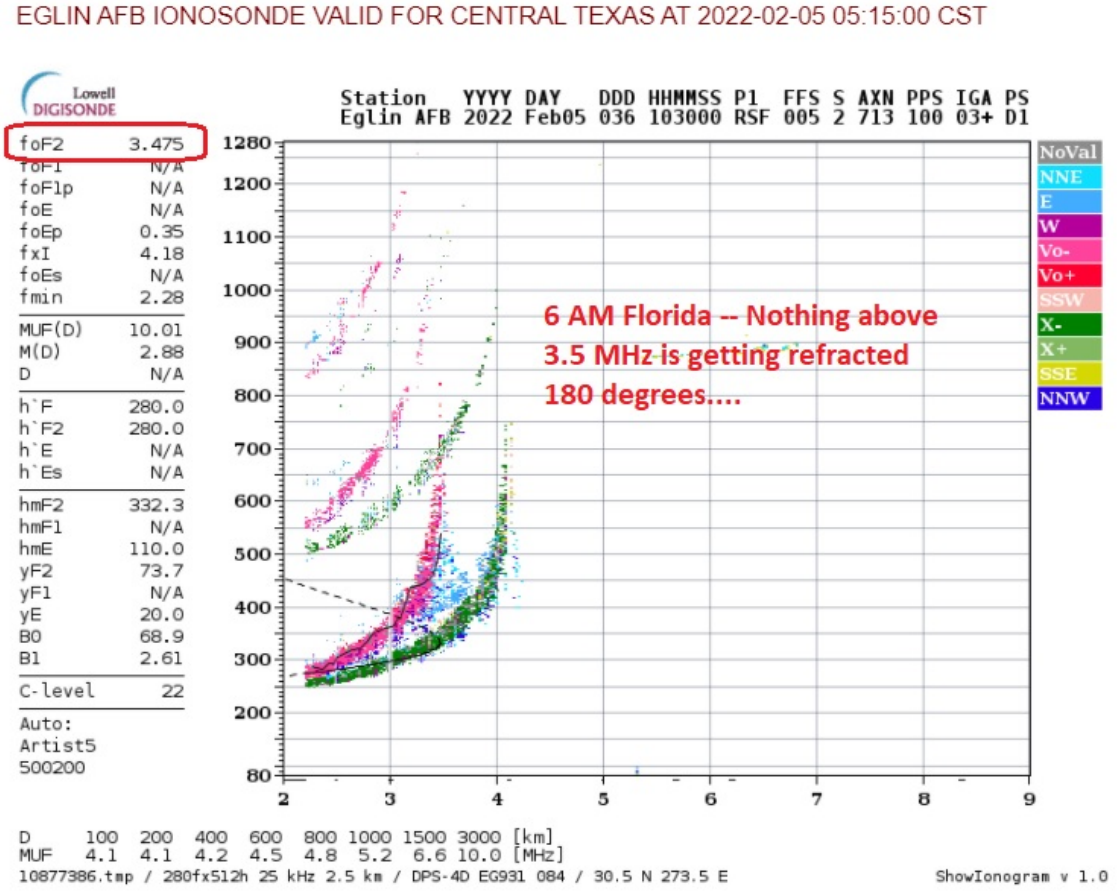
Ionized layers with very few air atoms maintain ionization longer

- Much more ionized during Daytime (D / E / F layers)
- Much less ionized during nighttime (F layer)
- **D LAYER IS THE DESTROYER LAYER** – destroys lower frequency waves
- D Layer approx 30 dB round trip destruction (80M)….worse by the square at lower frequencies
- This is why there is no DX during daytime on 80 meters
- This is why Daytime DX is on 20 / 17 / 15 / 10 meters
- Nighttime: D layer gone, 20 is dead (no radiation) so DX moves to 40 meters…. And NVIS shifts to 80 meters (OR LOWER!!!)

Night Ionosphere

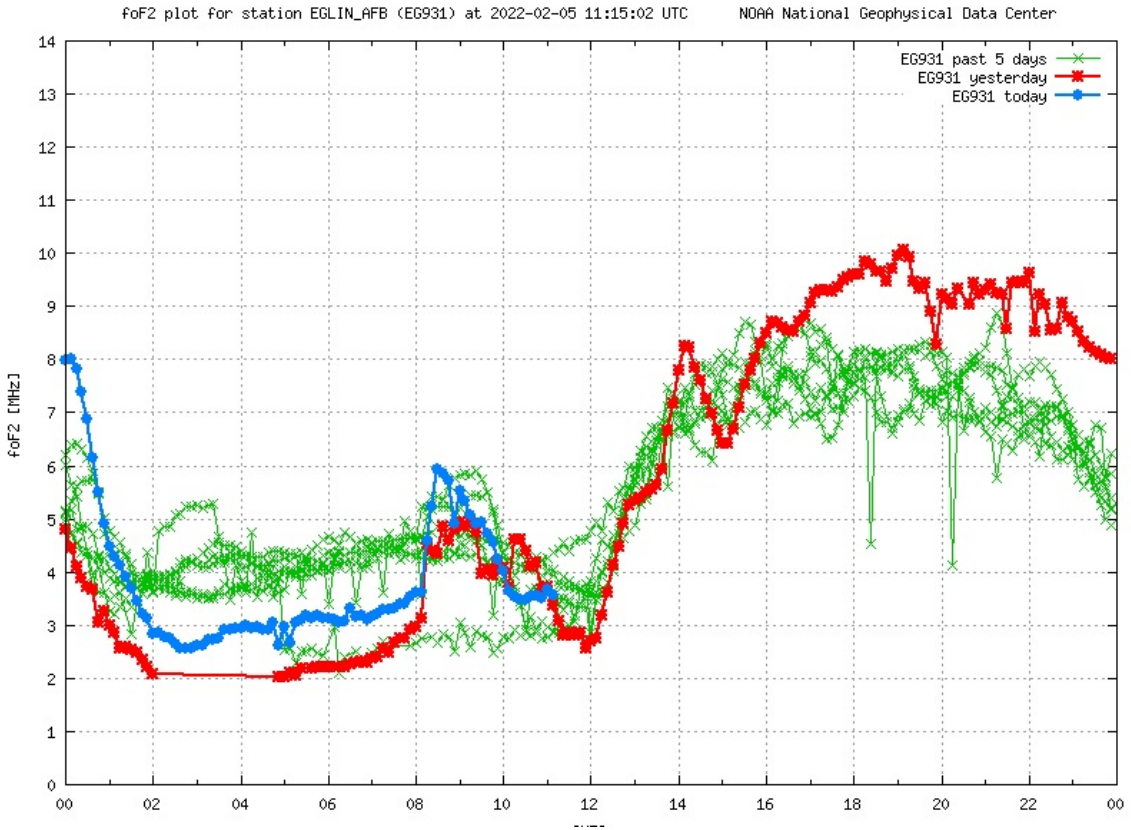
6AM Ionosonde

- **NVIS 3.425 MHz**



24 Hour Ionosphere

- NVIS all the way to 10 MHz middle of day.
- Glancing Waves (DX!) well above that during day



PURPOSE BUILT ANTENNAS!!

Expedient Antennas need to support the mission

VHF/UHF is much easier….

- Propagation is usually line of sight (especially to repeaters)
- Thickness-to-Length of elements favors wider bandwidth
- Dimensions much more tractable for solid elements
- ¼ verticals (radials) or horizontals far more easily constructed
- A single connector and a few wires and you have a working ¼ vertical with radials!

Expedient HF Antennas

More effort required here….

- **IF: No Antenna Tuner:** much more concern to get reasonable impedance, resonant antennas, more difficult to get multiband antennas
- Tip: Easy to build (or purchase) 4:1 current balun – allows OCF (off center fed) dipole good for MANY bands.
- **IF: Antenna Tuner** (esp. automated): much easier to create multi-band solutions; much easier to utilize lower-loss feedlines….or “expedient feedlines”

Favorite HF Solutions

- **Plain dipole, coax fed:** Design frequency and odd harmonics
- **Off center fed dipole, 4:1 CURRENT Balun, coax**: multiple bands, usually difficulty with the THIRD harmonic. Smooths out on higher and higher bands
- **¼ Wave Verticals:** ***not so often used*** (little vertical radiation) but in a pinch….use what you can
- **Any version of inverted Vee** – only one high support needed
- **Ladder / Window /** extension-cord fed antennas…..require antenna tuner!

Dipole Height Affects Lobes

Antennas for DX vs NVIS are placed at very different heights!

- REF: https://www.qrz.ru/schemes/contribute/arrl/chap3.pdf
- **But….there is a HUGE TRADEOFF with ground LOSSES**

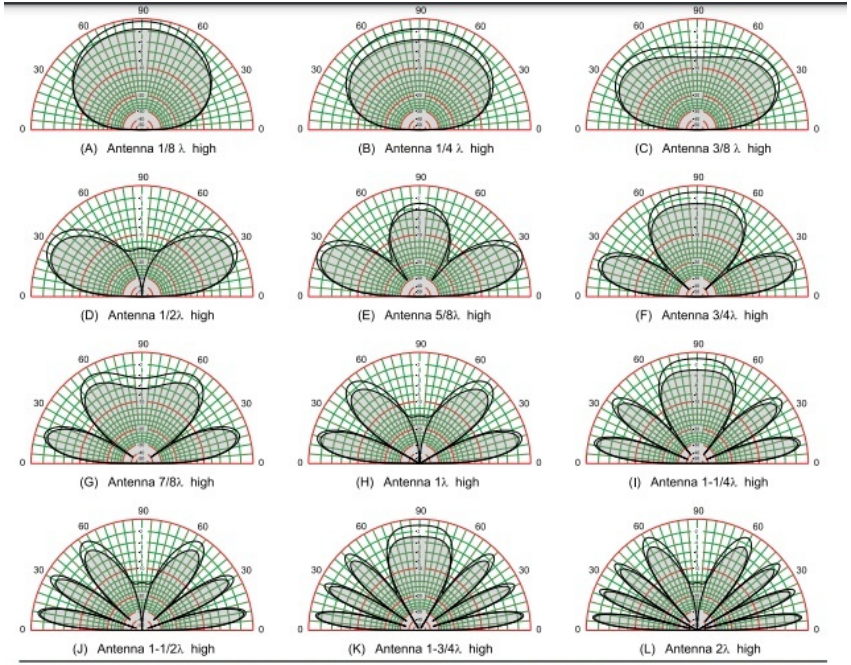
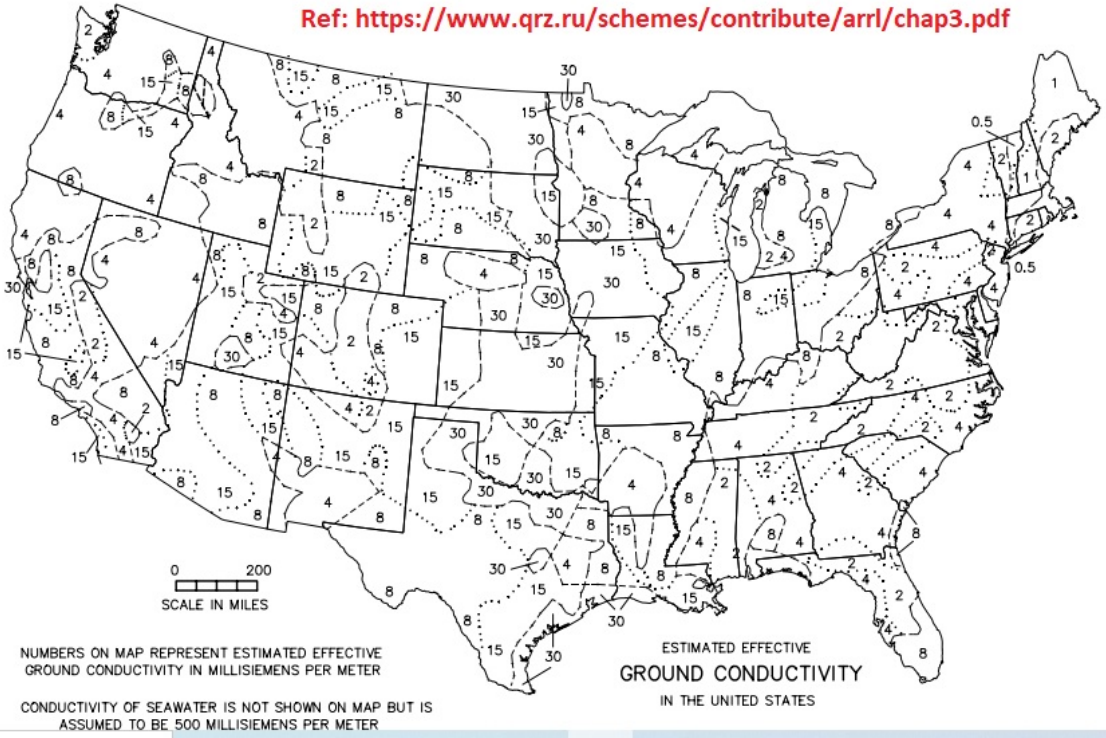


Fig 12—Reflection factors for horizontal antennas at various heights above flat ground. The solid-line curves are the perfect-earth patterns (broadside to the antenna wire); the shaded curves represent the effects of average earth (k = 13, G = 0.005 S/m) at 14 MHz. Add 7 dB to values shown for absolute gain in dBd referenced to dipole in free space, or 9.15 dB for gain in dBi. For example, peak gain over perfect earth at ⅜ λ height is 7 dBd (or 9.15 dBi) at 25° elevation.

Low Dipole Ground Losses

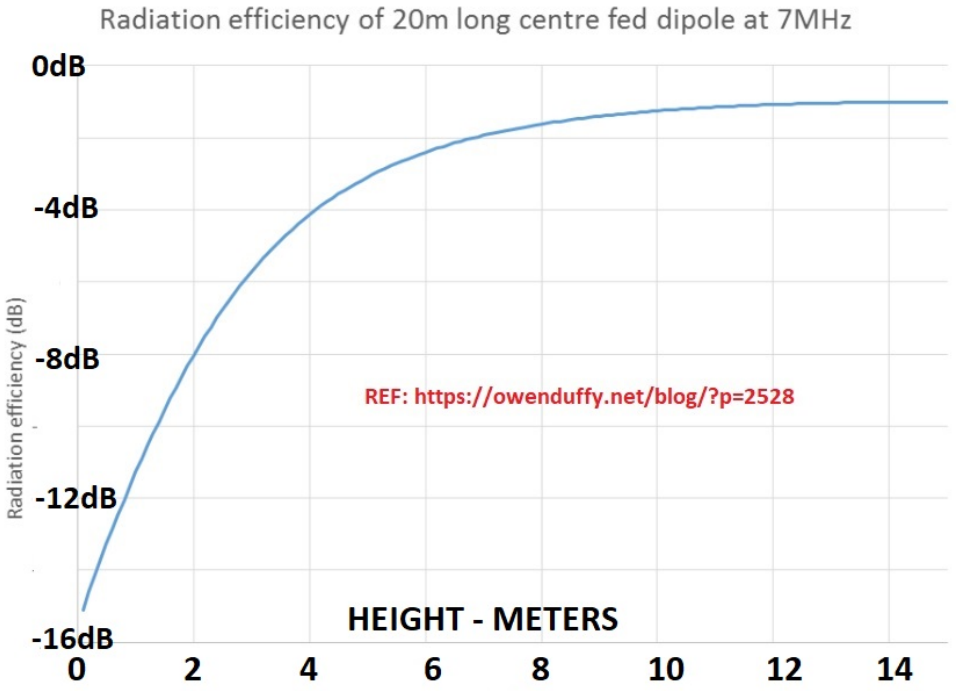
Traditional low-placed dipoles may encounter LARGE ground losses in poor soil

- **Plain dipole mounted <15 feet above gound in my Florida may experience 10dB losses….**



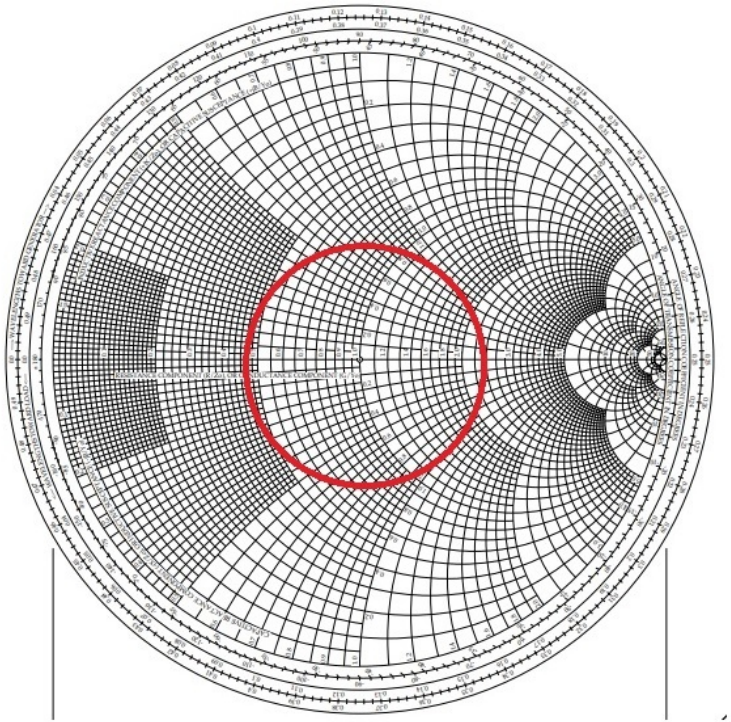
Lossy Ground & Low Dipoles

- **Losses really skyrocket when the antenna is below 10 feet.**
- Not hard to get an antenna to 15-20 feet.
- Chart is from calculations. Not sure WHAT conductivity was assumed….Florida is extremly poor.

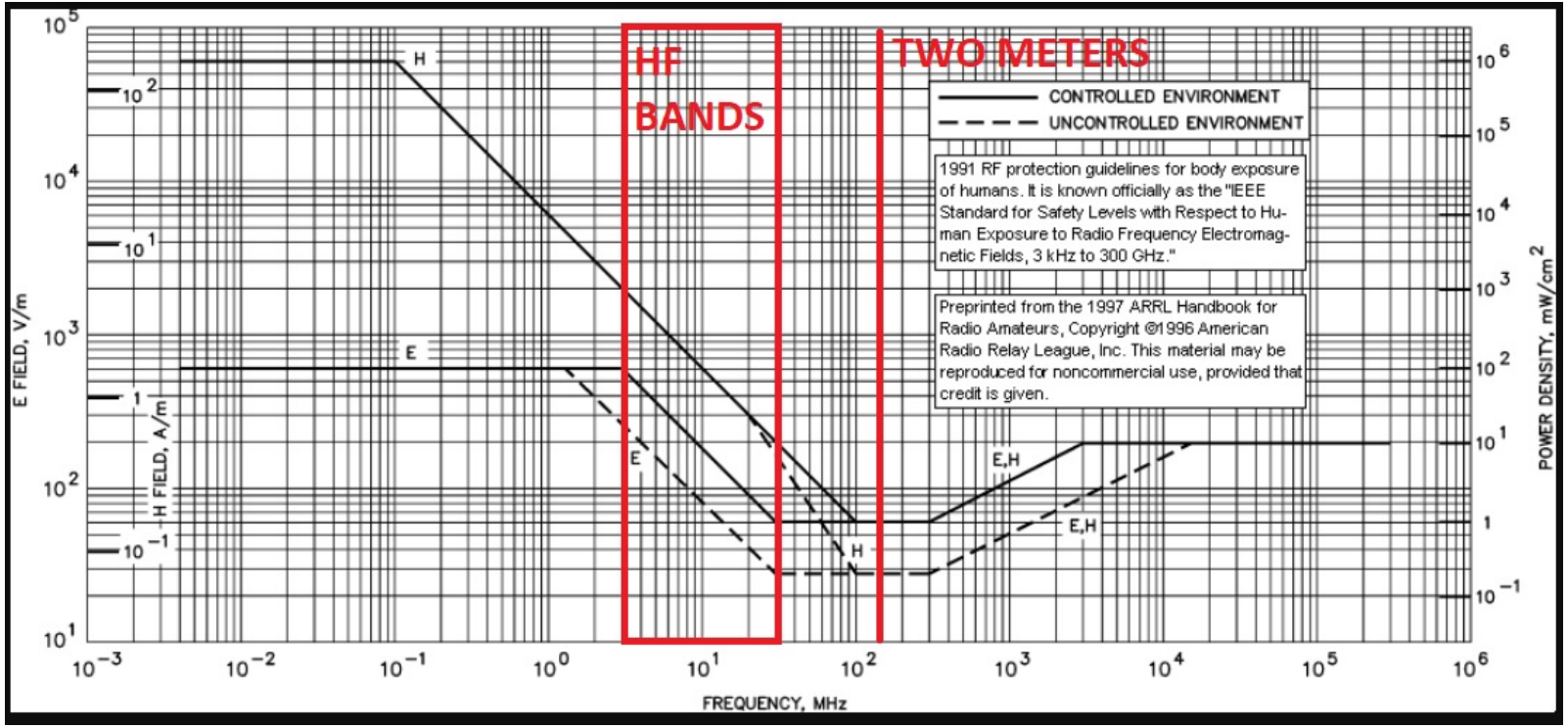


Expedient Feedlines

- Unusual feedlines may have bumps in characteristic impedance, higher losses, unusual impedances
- NEVERTHELESS… they can only present a SINGLE IMPEDANCE at the transmitter end….
- If your antenna tuner can match that impedance….you can use the antenna!
- **LOSSES of a non-professional feedine may be higher….but getting the antenna IN THE CLEAR and above GROUND LOSS may substantially outweigh the losses**.

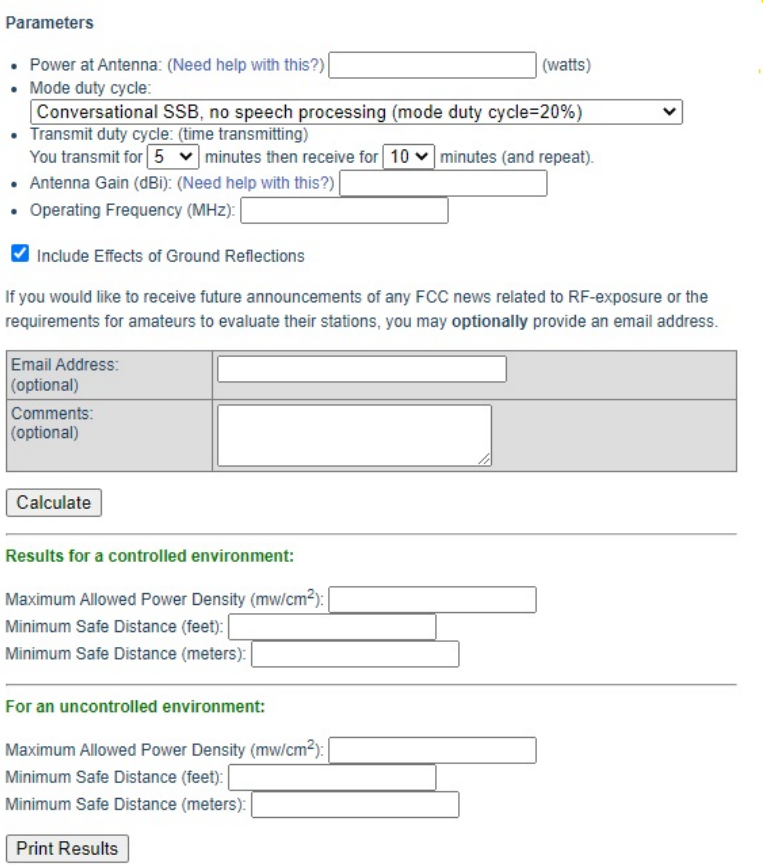


Exposure: SAR Limits



ARRL Exposure Calculator

- http://arrl.org/rf-exposure-calculator
- EASY to use

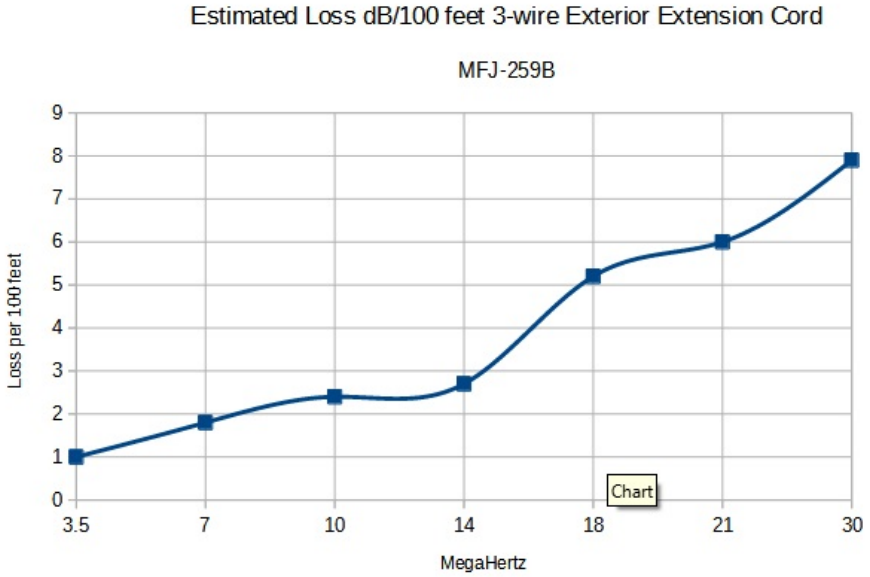


Time For Demo! Expedient Antennas

- **VHF:** Folded Up 2 Meter ¼ Wave Vertical
- **HF:** Extension Cord Dipole / Transmission Line
- 3-wire WALMART Exterior White Extension Cord Characteristic Impedance Measured = **81 Ohms (Black vs (white-green)**

3 Wire Extension Cord Transmission Line

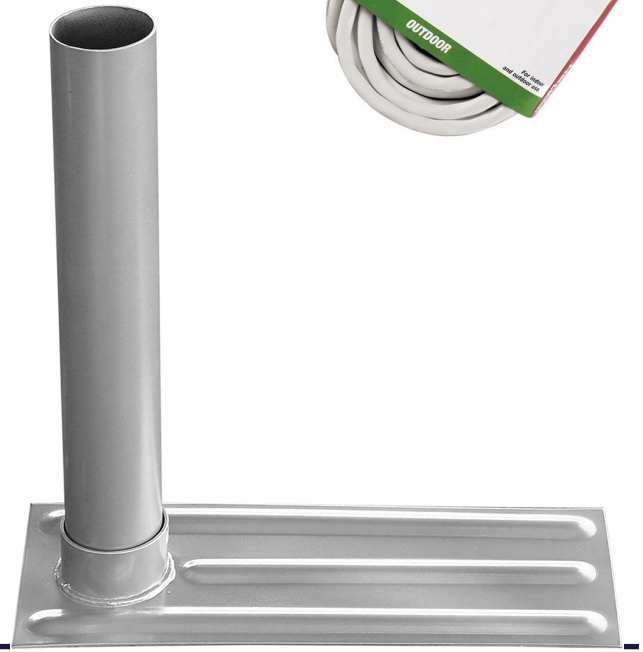
- **EXCELLENT at typical 80/40/2(M disaster comms bands!**
- **Loss goes up fairly fast with frequency**
- Even at 30 MHz, Up to 100 feet, LESS LOSS than ground loss of <10 foot antenna in Florida
- Use to get that antenna UP if you have no coax….



Open- and short-circuit losses measured by MFJ-259B averaged, adjusted to 100 feet.

Let's TRY IT!

- Roll-On "Flag Pole Wheel Stand" https://www.amazon.com/gp/product/B00KVE400Q
- PVC mast in sections
- Extension Cord Antenna
- Selectable feedline extensions (AKA extension cord)



Thank You!