# NVIS - The Ultimate Fallback Emcomm Resource

Presented by

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# What is NVIS?

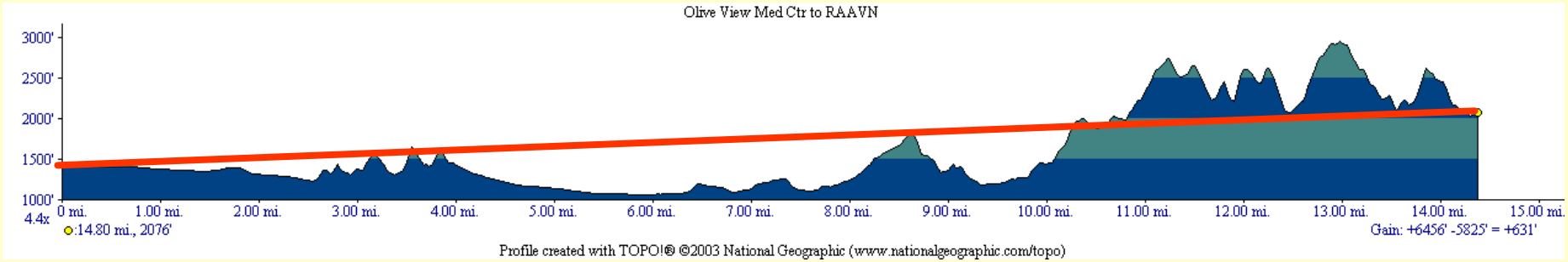
- **Near-Vertical Incidence Skywave**

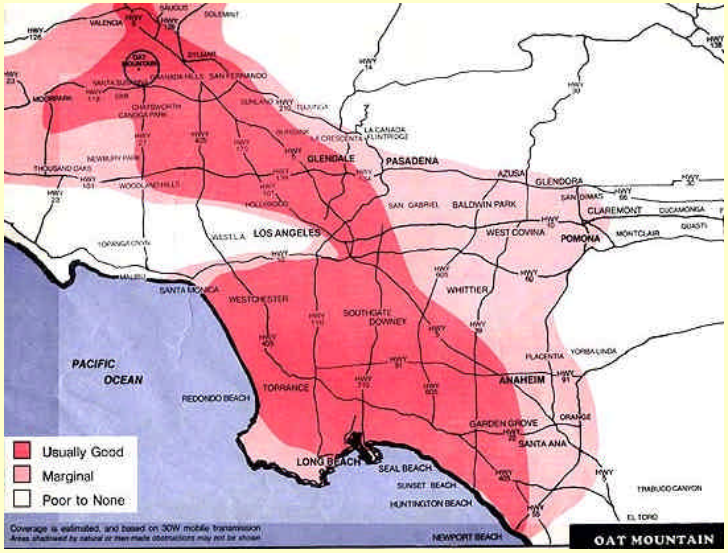
- A method of regional communication that does not rely on infrastructure, is immune to terrain and other obstructions and supports multiple simultaneous, independent users

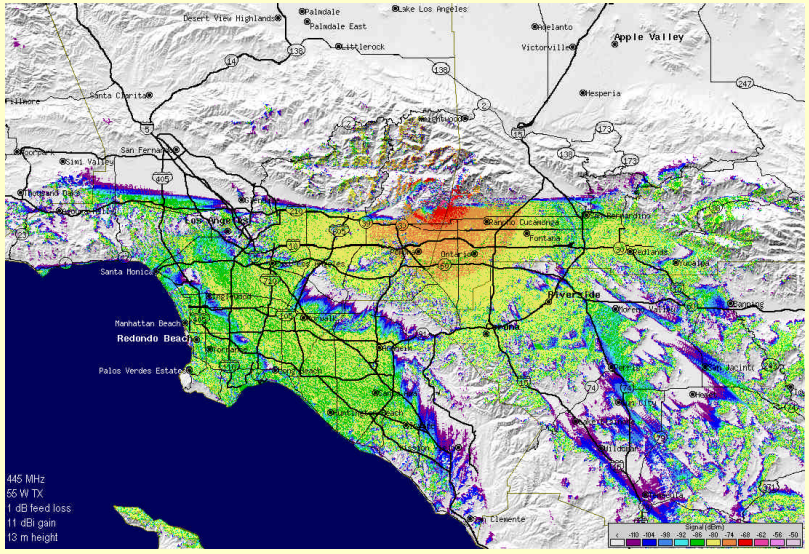
# Repeaters are great, but . . .

- Site power disruption or surge damage
- Site antenna or building damage
- May be hard to access for repair
- Intentional interference (jammer)
- Unintentional interference (other users)
- Only one communication at a time

# Repeaters have coverage issues



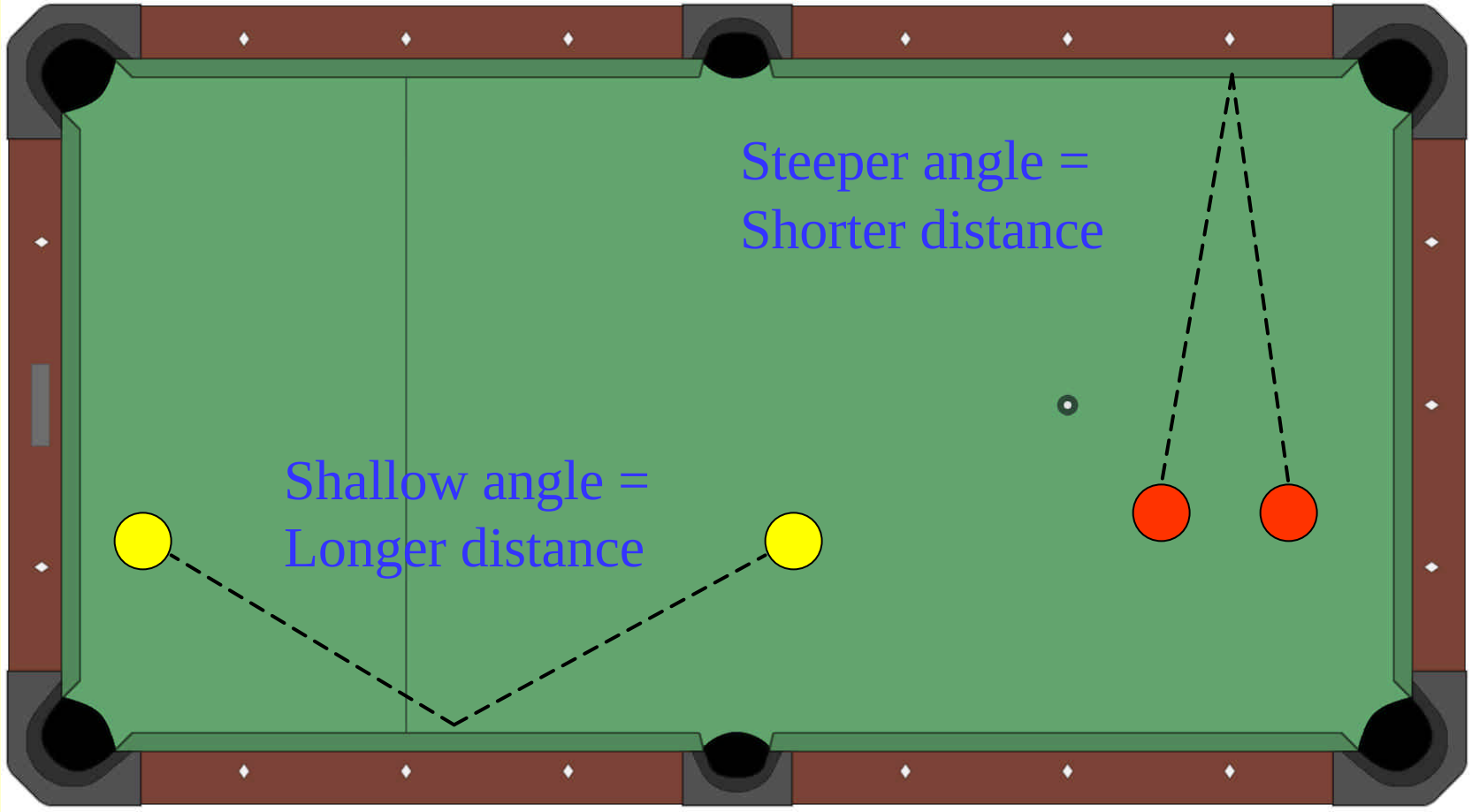



# How can we “spray” an area with RF?

# The ionosphere refracts MF & HF

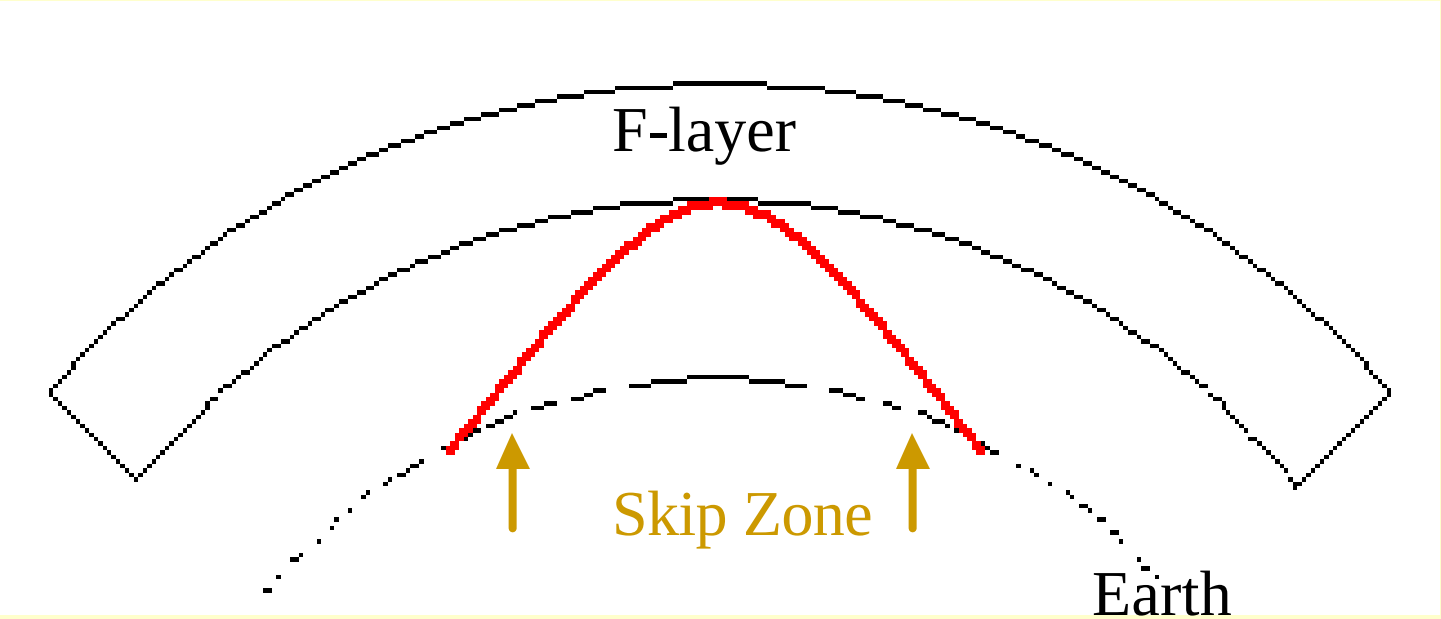
- Surface and direct waves: 40 to 80 miles at best
- **Sky waves**: can reach anywhere on earth !
- But where on the earth? It depends on the angle at which the wave approaches the ionosphere – the angle of **incidence**

# Angle of incidence determines distance



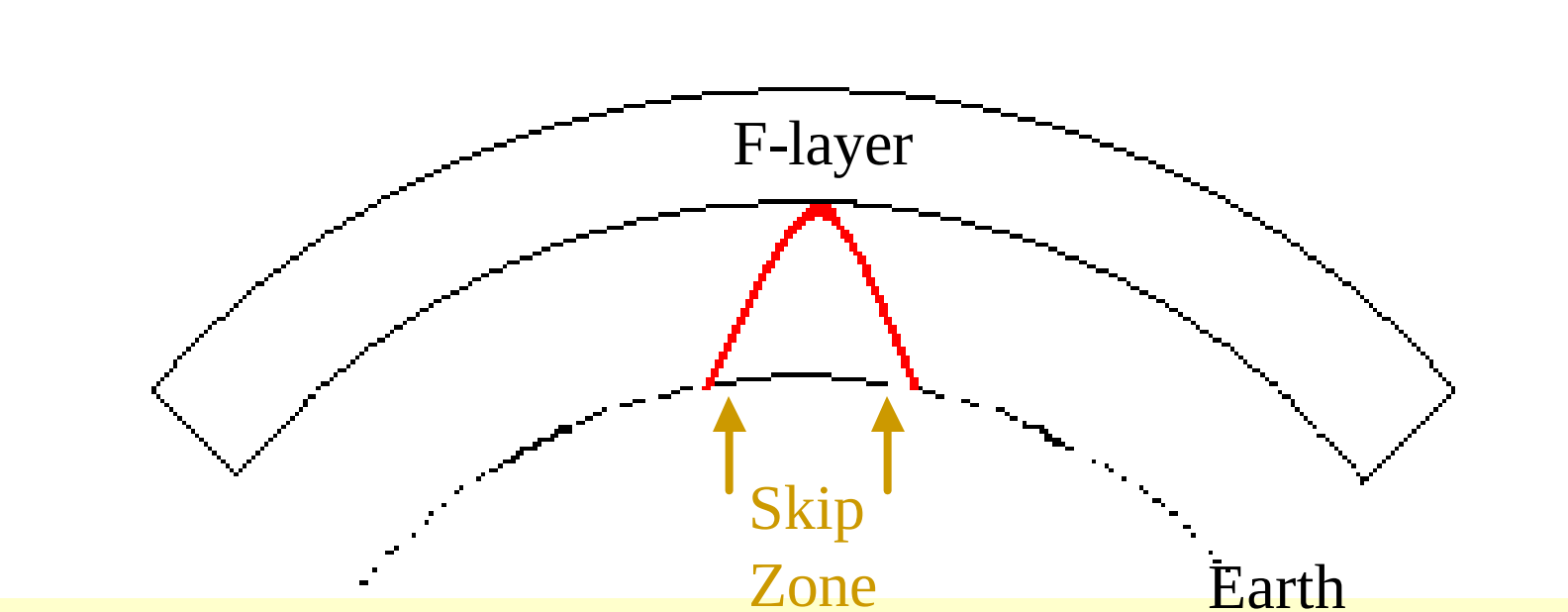
# Shallow angle = longer distance

- Low angles can reach over 1,000 miles
- Multiple hops can span the globe
- But . .. There's a gap: the "skip zone"

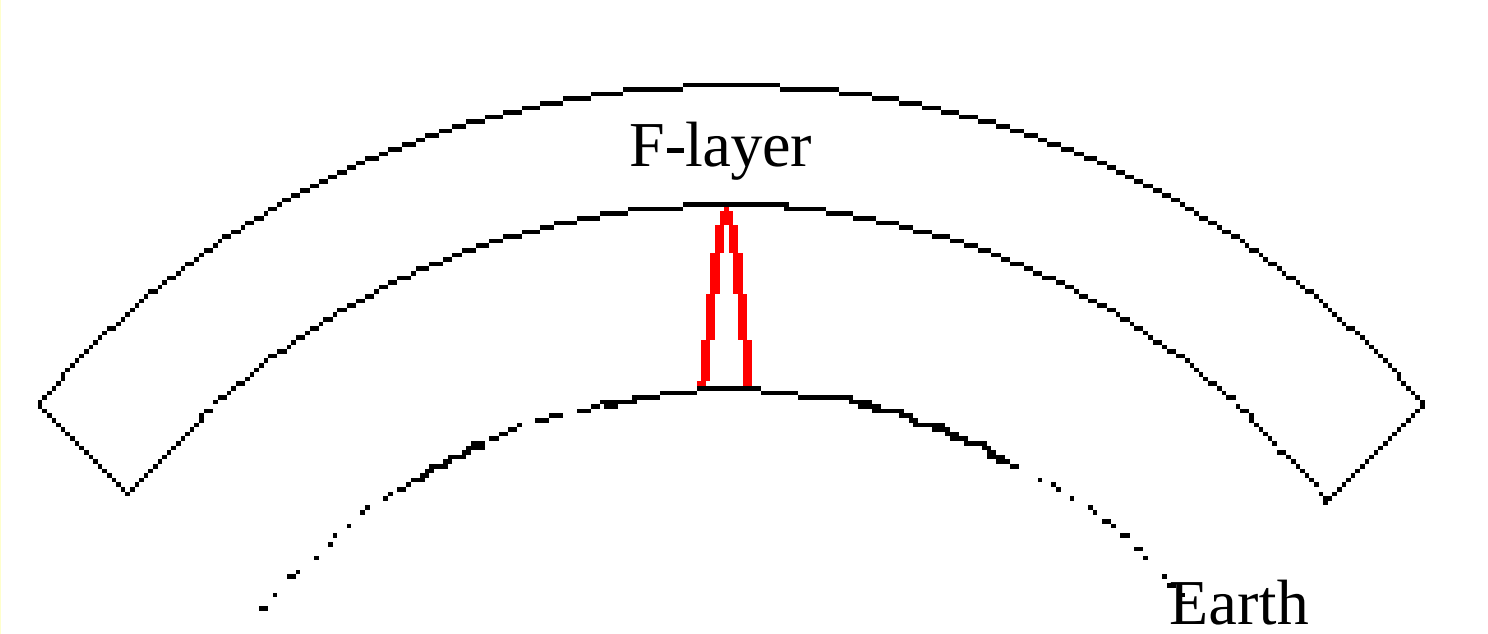


# Steeper angle = shorter distance

(The size of the skip zone is reduced)



A **near-vertical** angle eliminates the skip zone entirely . . .
Just what we need!



# However, there are limitations

- Above the **critical angle**, no refraction occurs
- Critical angle varies with frequency
  - - Higher frequencies = lower critical angles

- High-angle signals **do not get ionospheric refraction** on the higher bands; they just pass on into space.

# So NVIS is not for the high bands

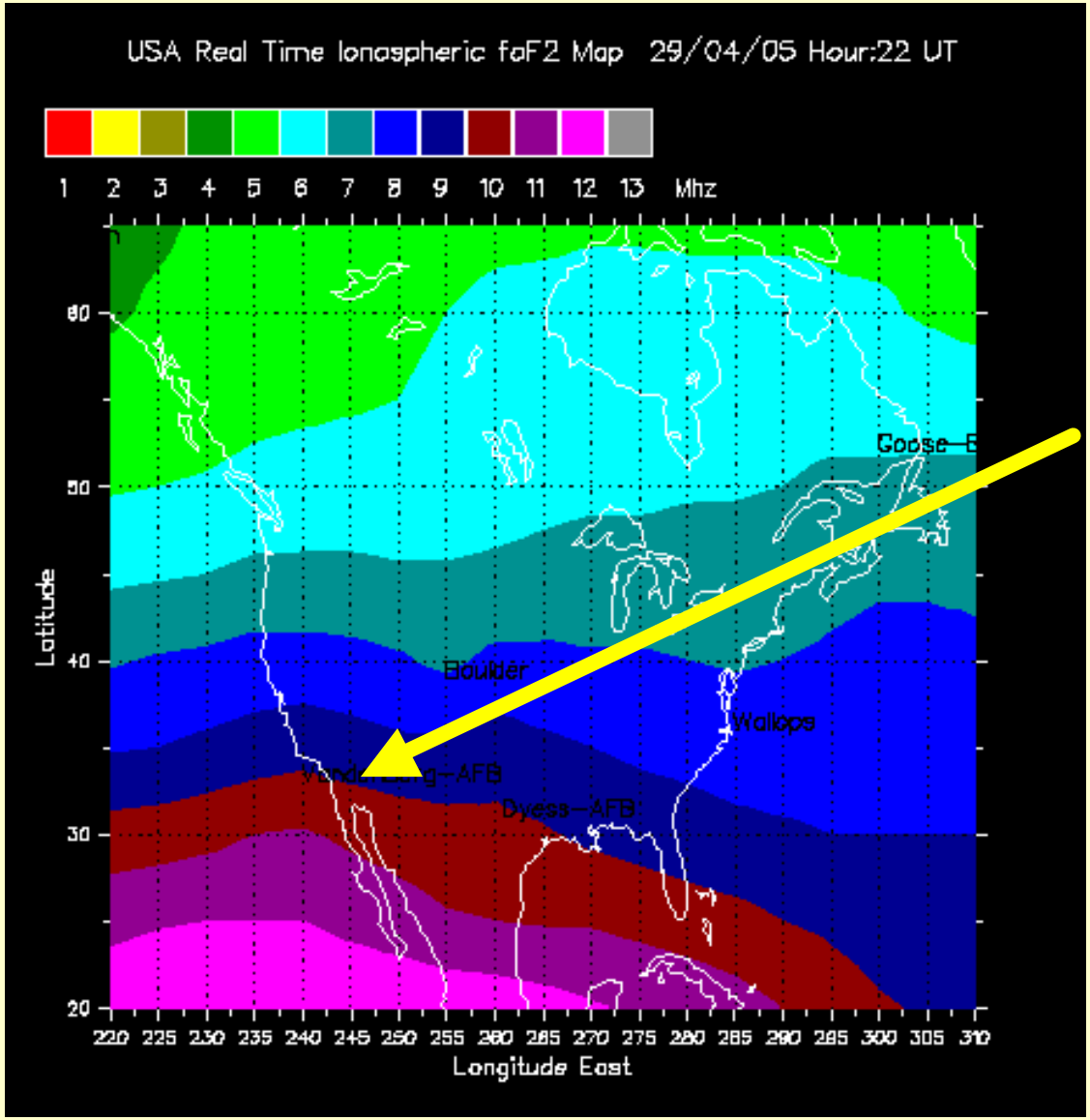
- 10- and 15-meter signals are refracted at low angles but never at high angles

- 20-meter signals going straight up **might** be refracted, but **only** when sunspots and solar activity are plentiful (many sunspots, daytime)

  Even then, 20m is seldom optimal for NVIS

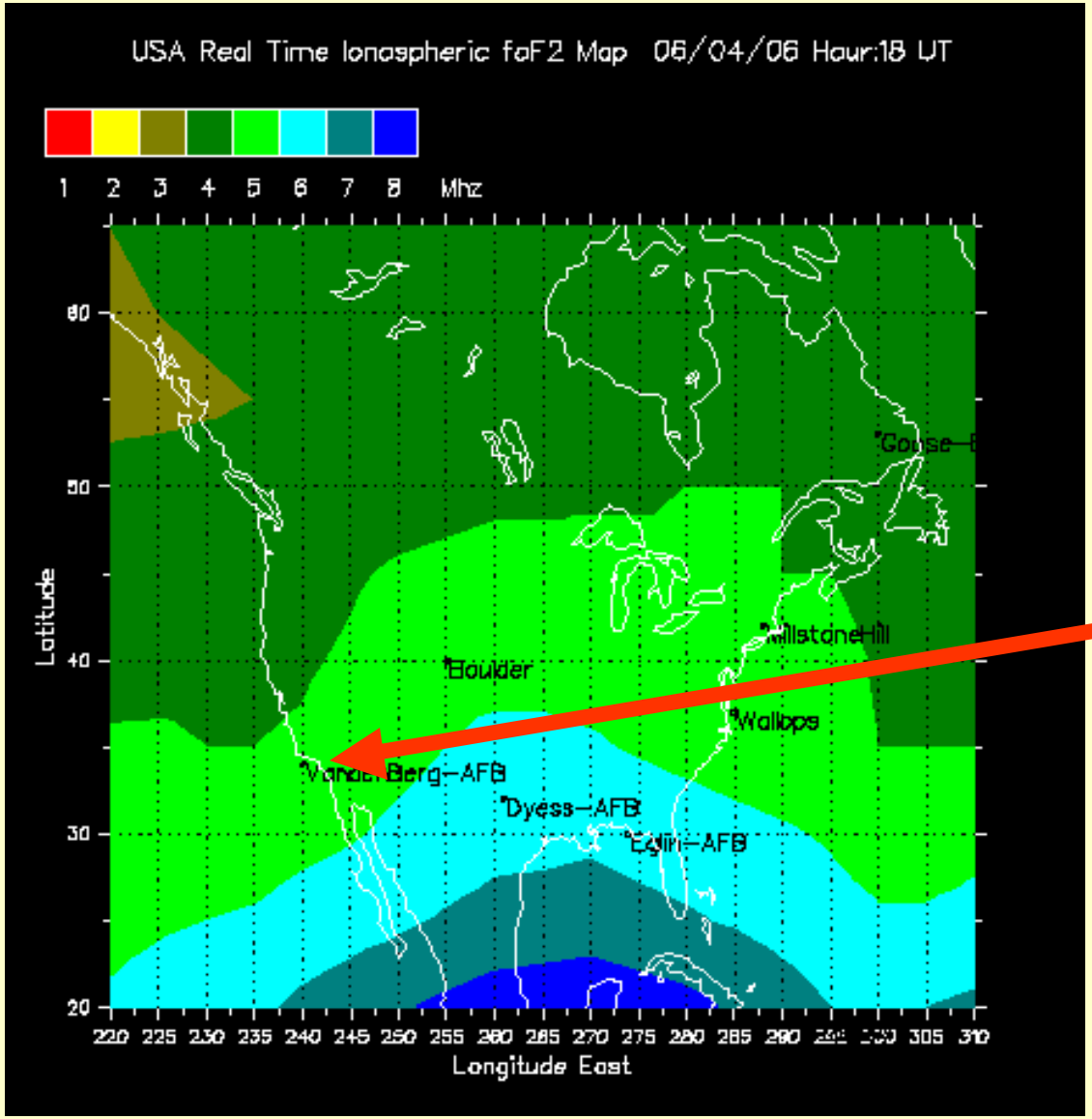
# That leaves 160, 80, 60 and 40 meters

- The lower the frequency, the more reliable the vertical-angle refraction
- Reliability decreases as you approach **foF2** (a.k.a. **critical frequency**)
- foF2 is the highest frequency at which a signal sent straight up is reflected back down
- foF2 increases during the day (as the F-layer gets more ionized) and drops at night

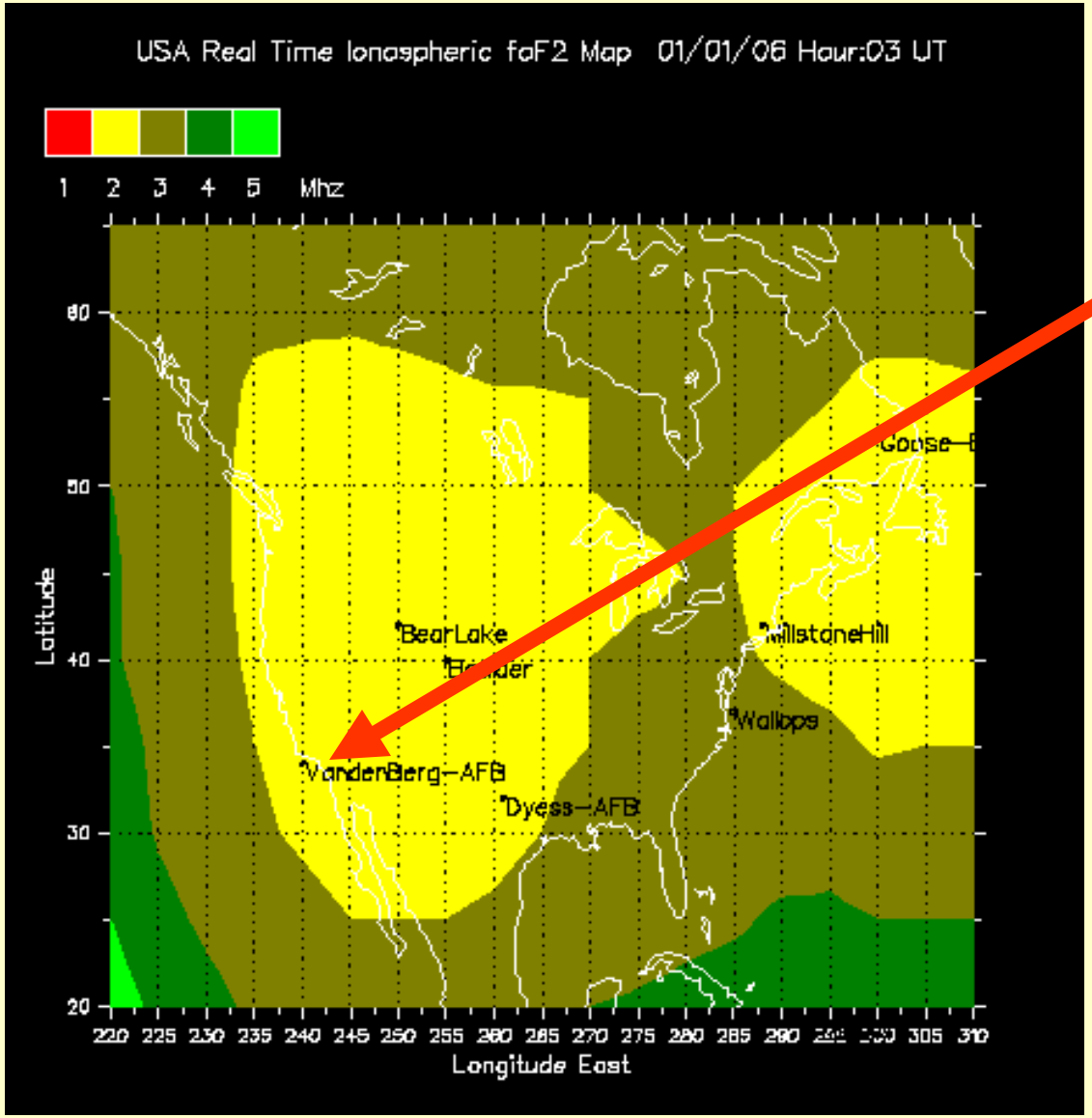



Here our critical frequency is close to 10 MHz. This was several <u>years before</u> the bottom of the solar cycle.

**“40m in the daytime, 80m in the nighttime”**




This is a typical daytime scenario during the low part of the sunspot cycle. Our foF2 is at 5 MHz (our 60m band).




On this evening our critical frequency is only around 2 MHz.

This is not unusual for nighttime during periods of <u>low solar activity</u>.

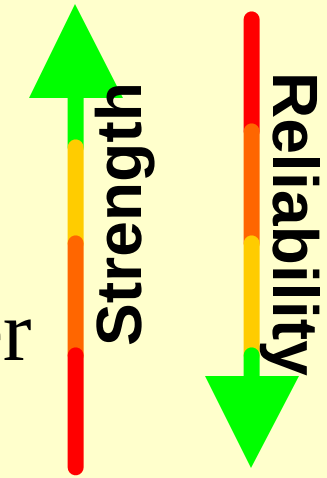
Critical frequency could get down as far as 1 MHz before morning.

# So, why not just use 160m all the time? Because of the D-layer

- The D layer lies below the F layer
- It absorbs RF signals when it’s ionized (i.e., during the daytime); it disappears at night
- The lower the operating frequency, the greater the D-layer attenuation (so it’s worst at 160m during the daytime)
- A M broadcast band effect

# F- and D-layer effects interplay

- Higher frequency means:
  - Less reliable refraction, but also
  - Less absorption or attenuation
- Higher frequencies will produce stronger signals UNTIL you reach foF2




- So pay attention to band selection, and plan on band changes during the course of a day!

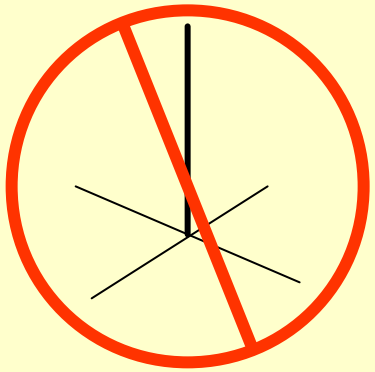
# Days on 80, nights on 160?

- This could be the rule during periods of very low solar activity.
- 60m or even 80m may sometimes be your best daytime band.
- You may have to go down to 160m at night.

# Enough about propagation! How do we get signals to go straight up?

- Low-angle radiation is great for DX (long distances) but not for NVIS communication.
- You want to emphasize the high-angle radiation pattern for both transmitting and receiving.
- Antenna **orientation** and **height** are key

# Start with polarization



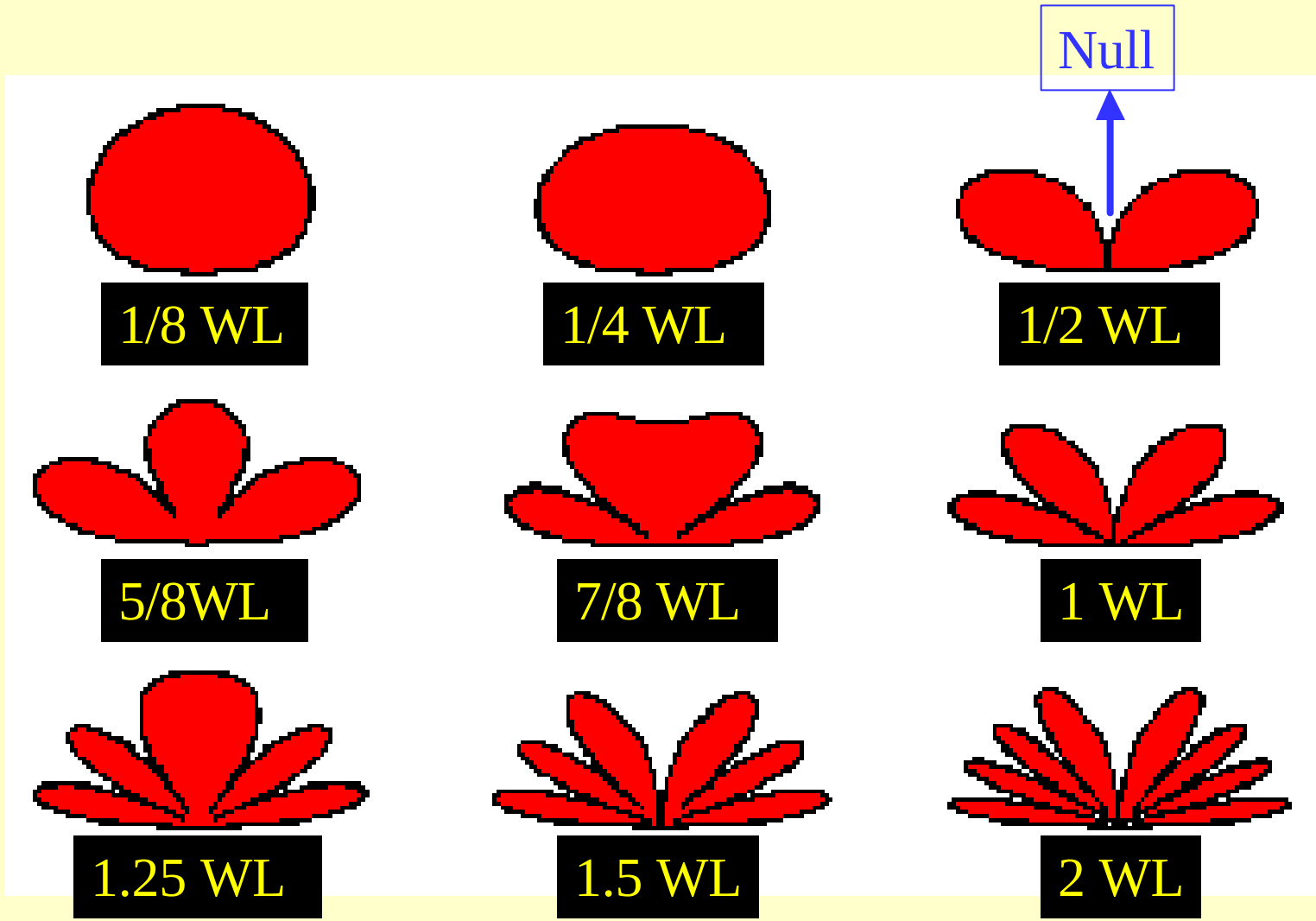
- Verticals have low takeoff angles
- They have almost no radiation straight up
- Great for DX, but bad for regional coverage

- **Horizontal** antennas can radiate high angles if put at an **appropriate height** over ground

# DXers need tall towers; **you don’t**!

- Antennas can be too high for NVIS
- At 1/2 wavelength up, main lobes are low
- Near the ground, main lobes are high
- ***Take a look at these radiation patterns . . .***

# How height affects elevation pattern



# Keep it low!

- For NVIS, stay at or below 3/8 wavelengths
- Closer to ground means less QRM & QRN
- Some efficiency loss as antenna gets closer to the ground

# Types of NVIS antennas

- Resonant dipoles
- Non-resonant doublets
- Off-center-fed (e.g., G5RV)
- Dipoles over reflector systems (e.g., screens)
- Horizontal loops
- Bent-over mobile whips (U.S. Army discovery)

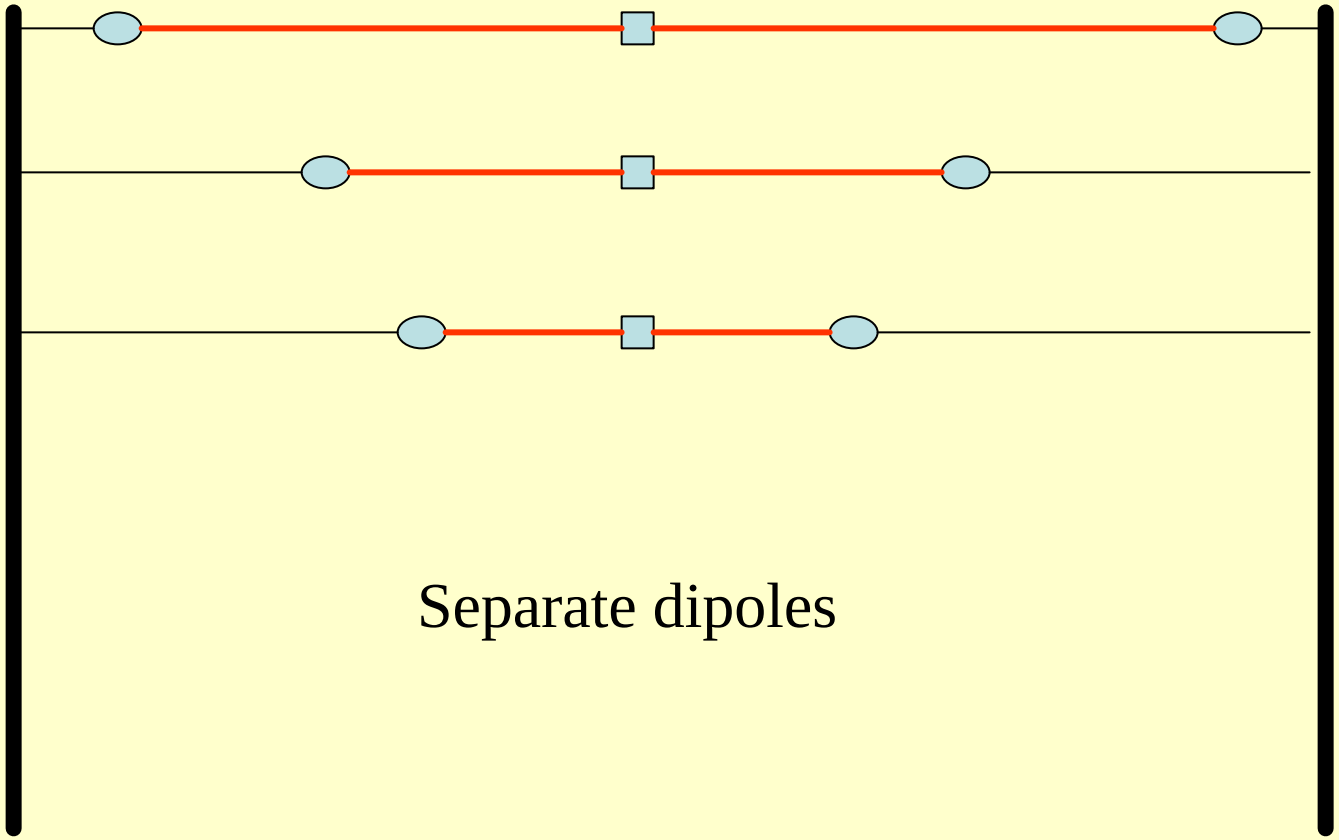
# NVIS antenna supports can be:

- trees
- vehicles
- portable masts
- outbuildings
- shrubbery
- even traffic cones!

# NVIS Antenna Strategy

- Portable and field antennas will be less efficient due to space, height and setup time
- “Command post” or “Net Control” antenna should be as efficient as possible
- Gains of up to 6 dB (i.e., 4 times) over a simple low dipole are possible
- Consider horizontal loop or Lazy H over a reflector screen for the central station

# Multi-band NVIS Antennas



Separate dipoles

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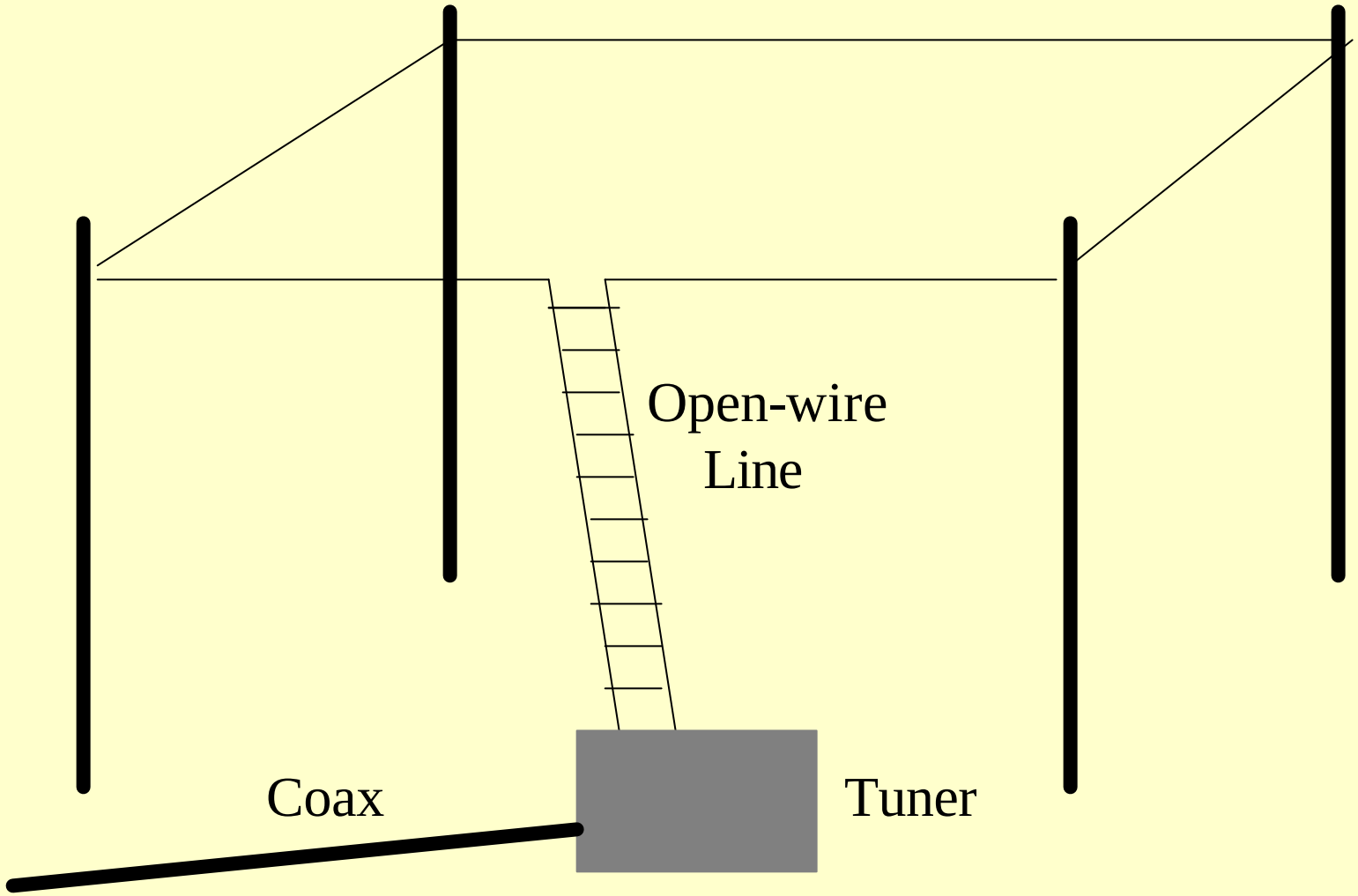

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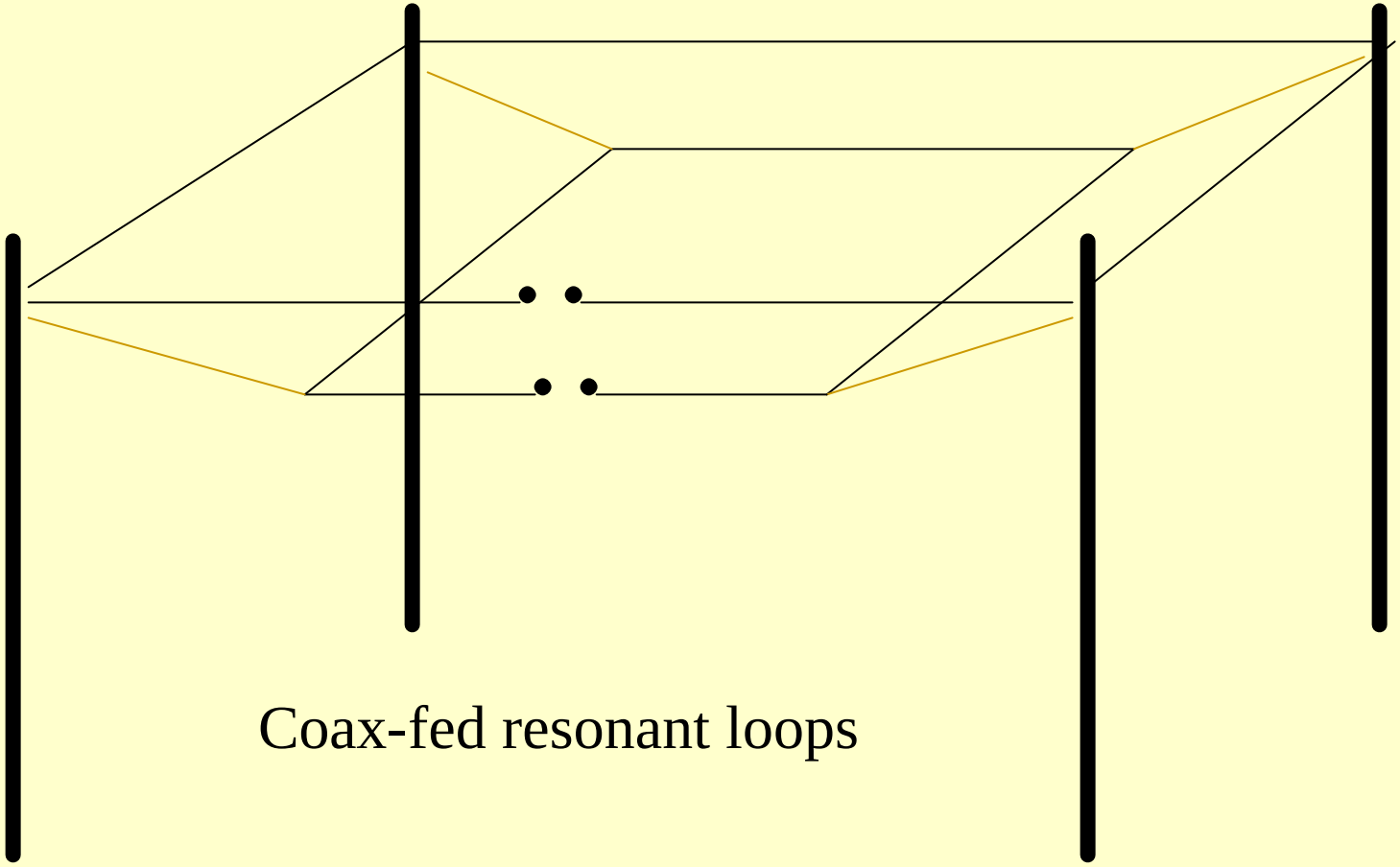
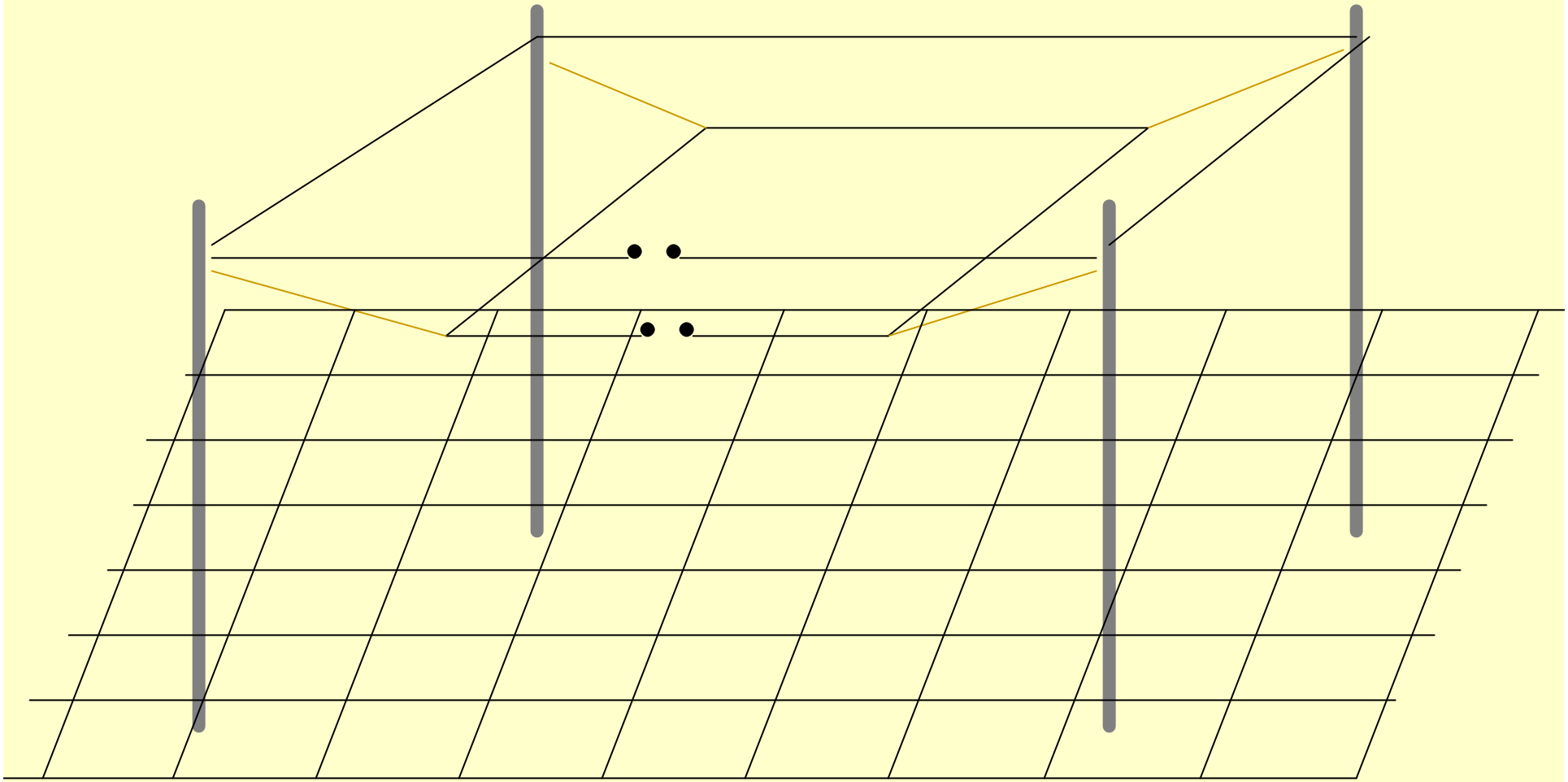


Coax-fed resonant loops

# Add ground screen for best gain



# Read more about it

- www.cebik.com
- QST Jan 1995, Jun 2002, Dec 2005
- QEX May / Jun 2007

# Thank You!

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