

# HF Propagation for Emcomm (and a little VHF, too)

Presented by

Marty Woll N6VI

Ass't DEC, ARES - LAX Northwest

Training Officer, LAFD ACS

Past ARRL SW Division Vice-Director



Copyright 2020 N6VI

# NVIS for Regional Coverage

- **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

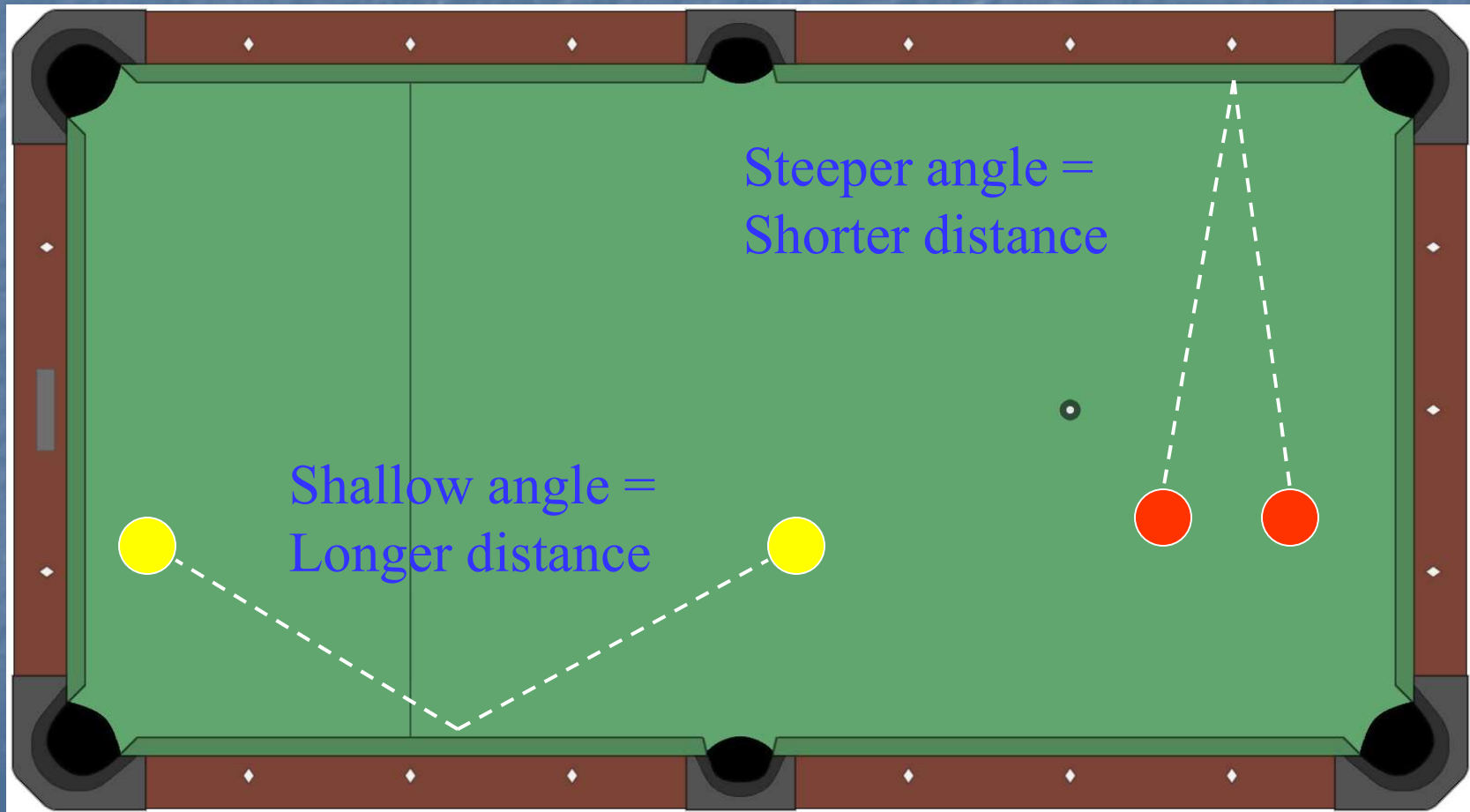
# How can we "spray" an area with RF?



# The ionosphere refracts MF & HF

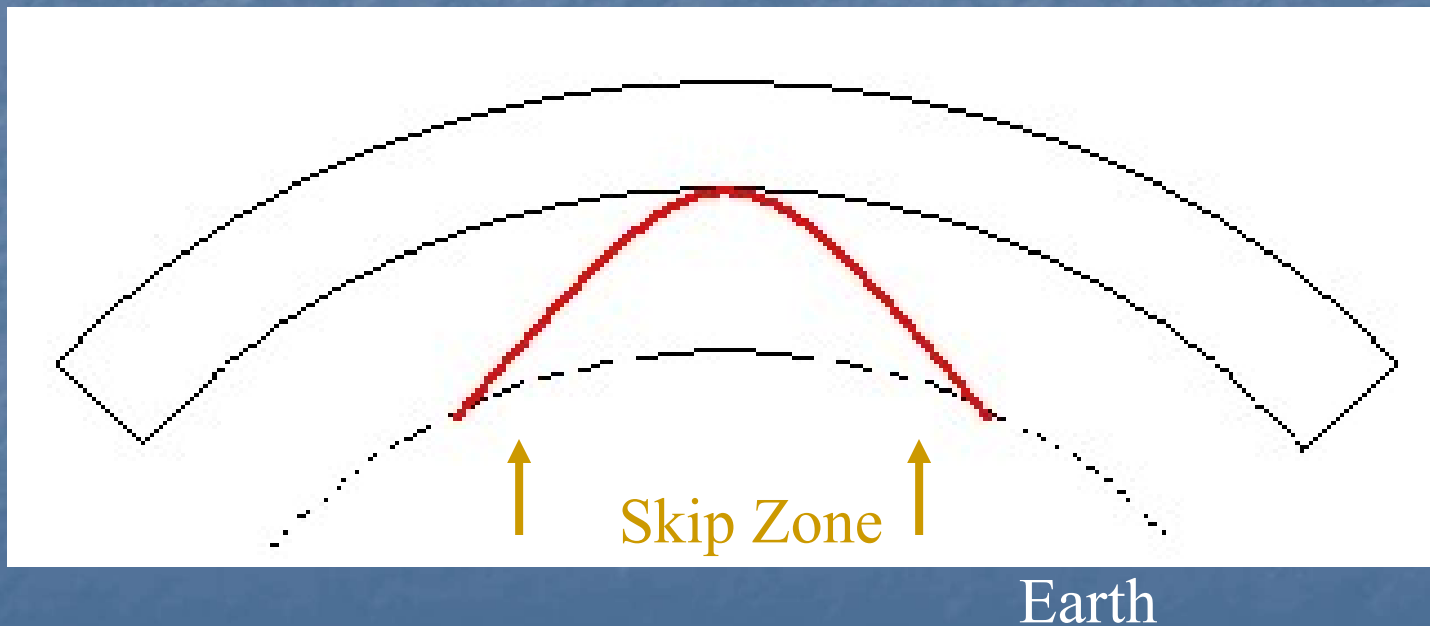
- Surface and direct waves: 40 to 80 miles at best
- **Sky waves**: can reach anywhere on earth !
- But where on the earth? It depends on the angle at which the wave approaches the ionosphere –the angle of **incidence**

# Angle of incidence determines start-to-end distance



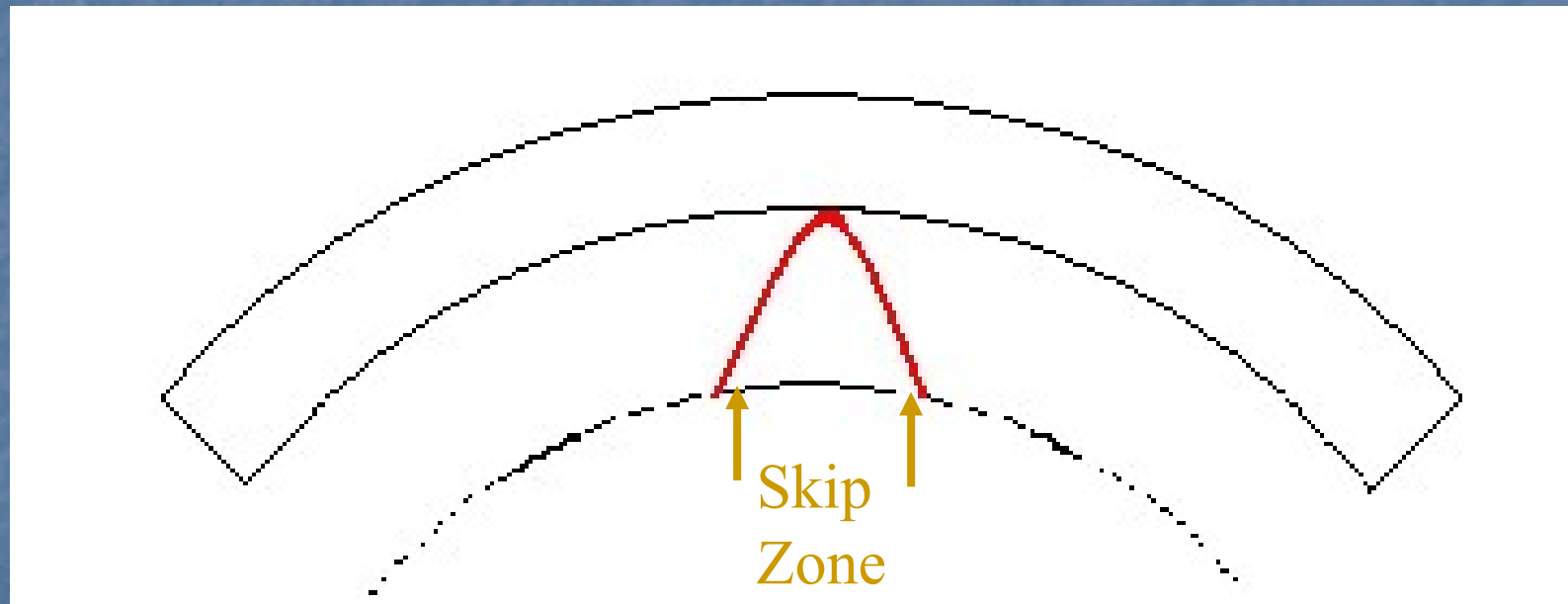
# Shallow angle = longer distance

- Low angles can reach over 2,000 miles
- Multiple hops can span the globe
- But . . . There's a gap: the "skip zone"



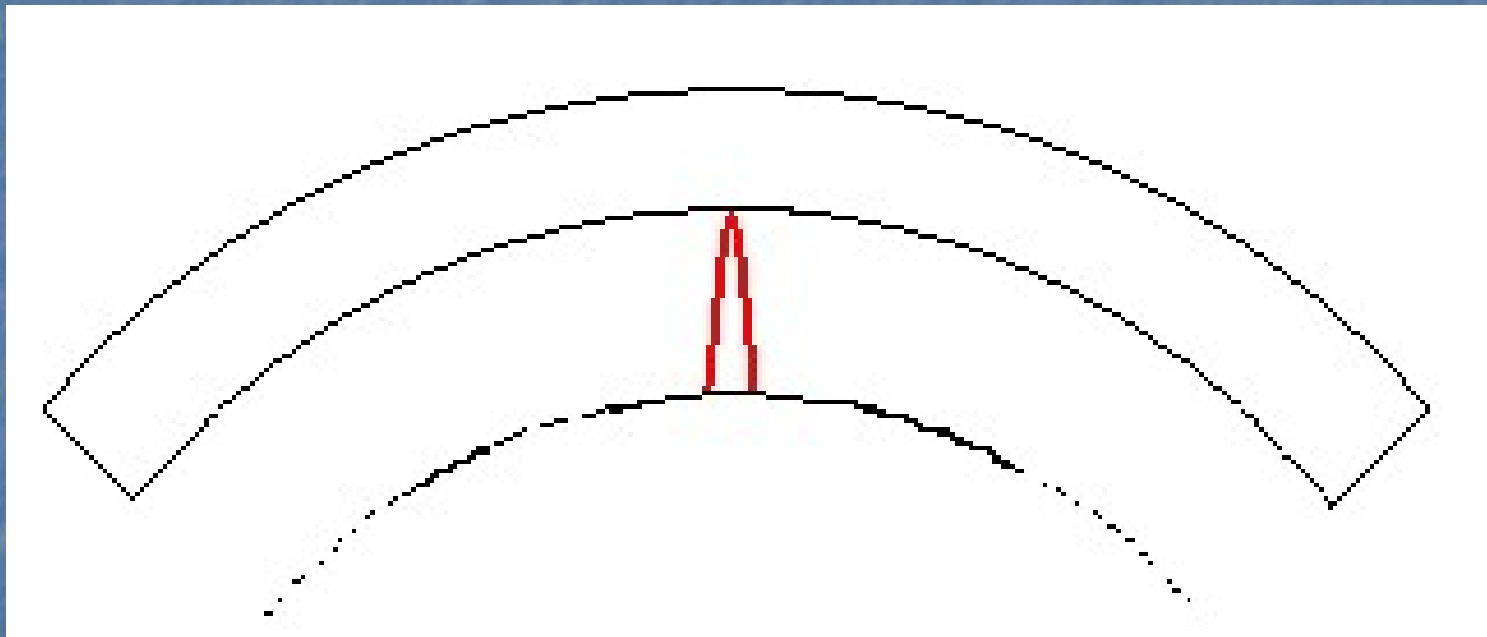
Steeper angle = shorter distance

(The size of the skip zone is reduced)



Earth

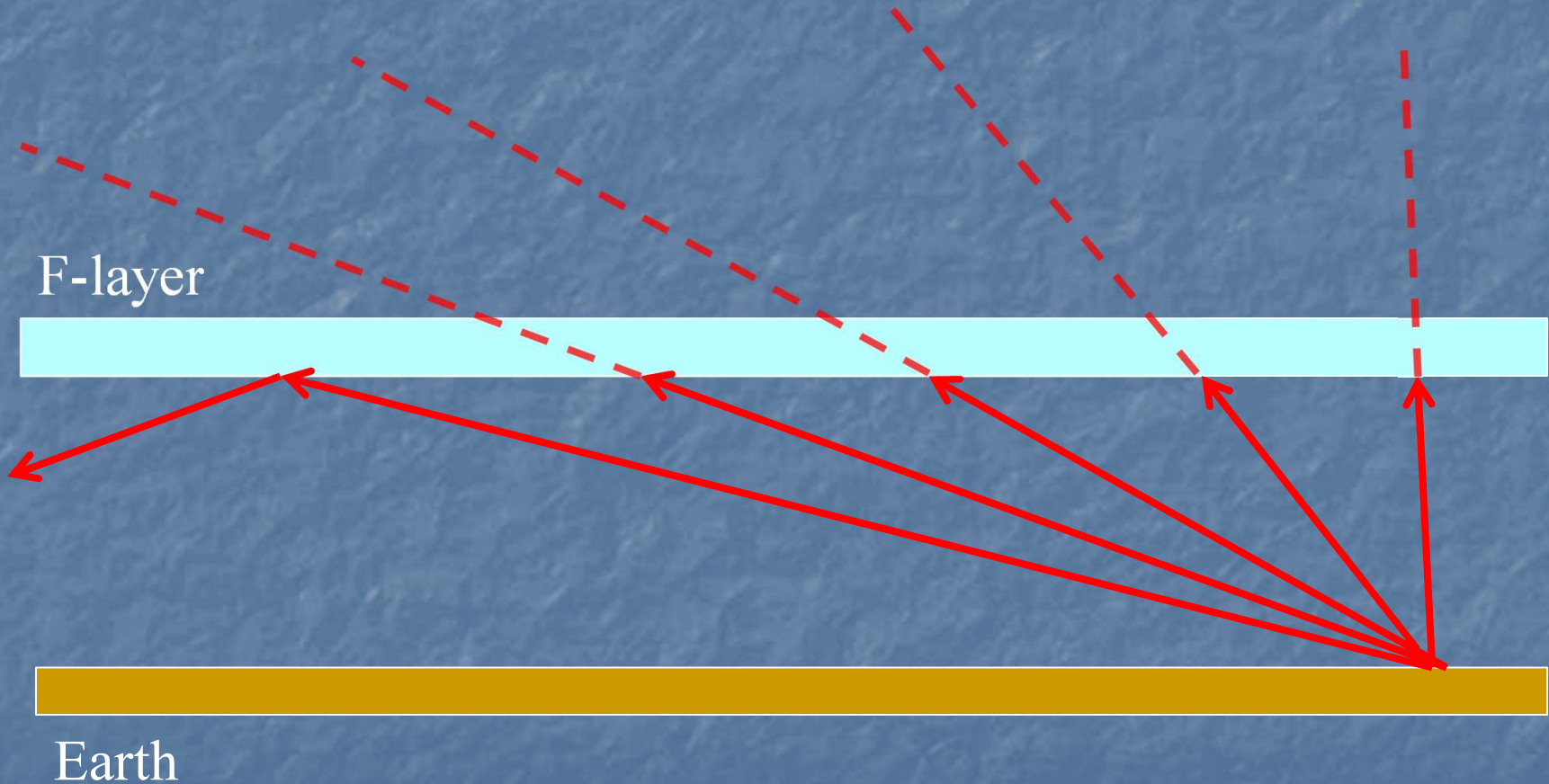
A **near-vertical** angle eliminates the skip zone entirely!



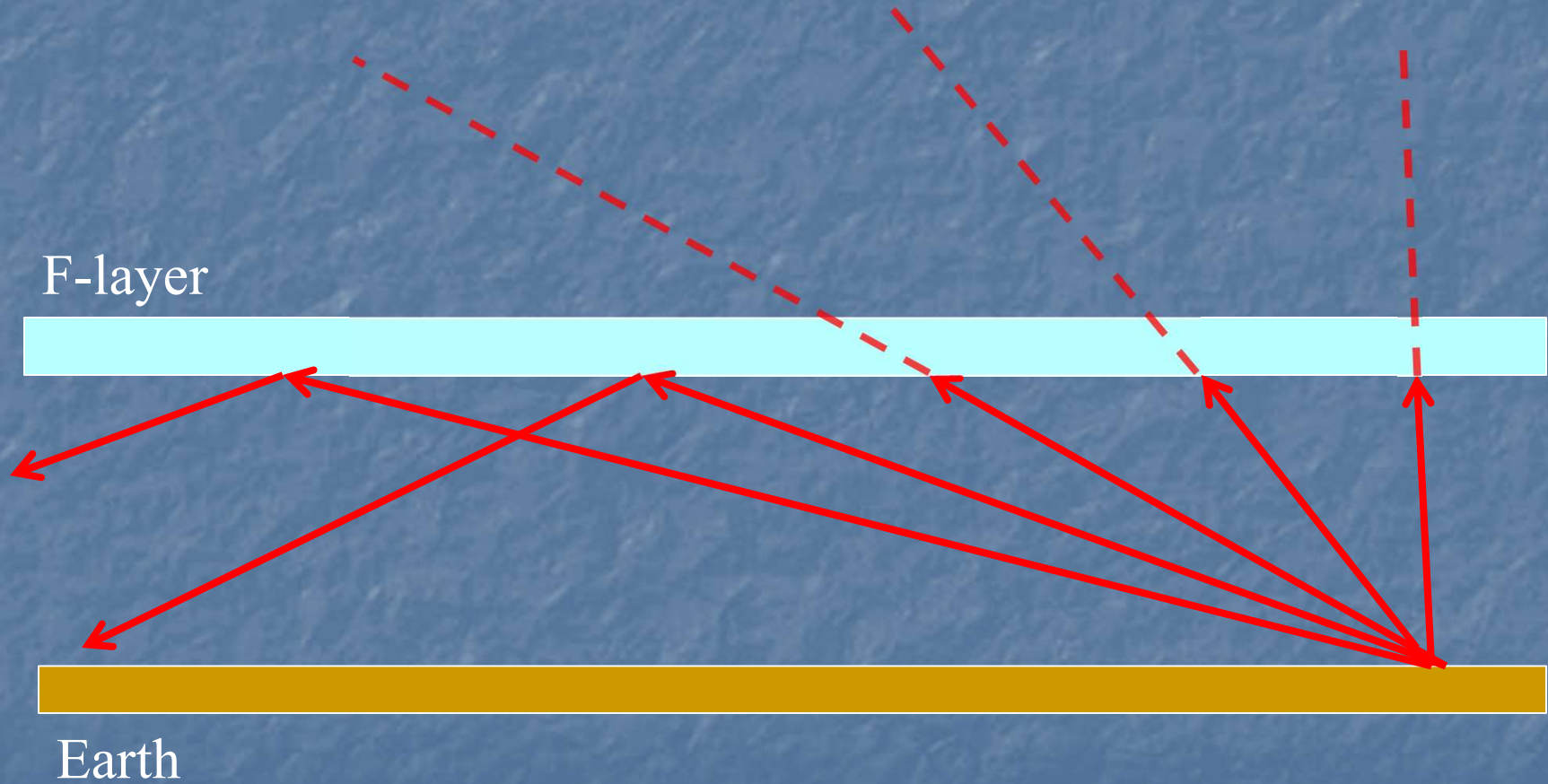
## However, there are limitations

- Critical angle varies with frequency
  - Higher frequency = lower critical angle
- For any given frequency, there is a **critical angle** above which no refraction occurs
- Above the **critical frequency**, high-angle signals get no ionospheric refraction; they just pass on into space.

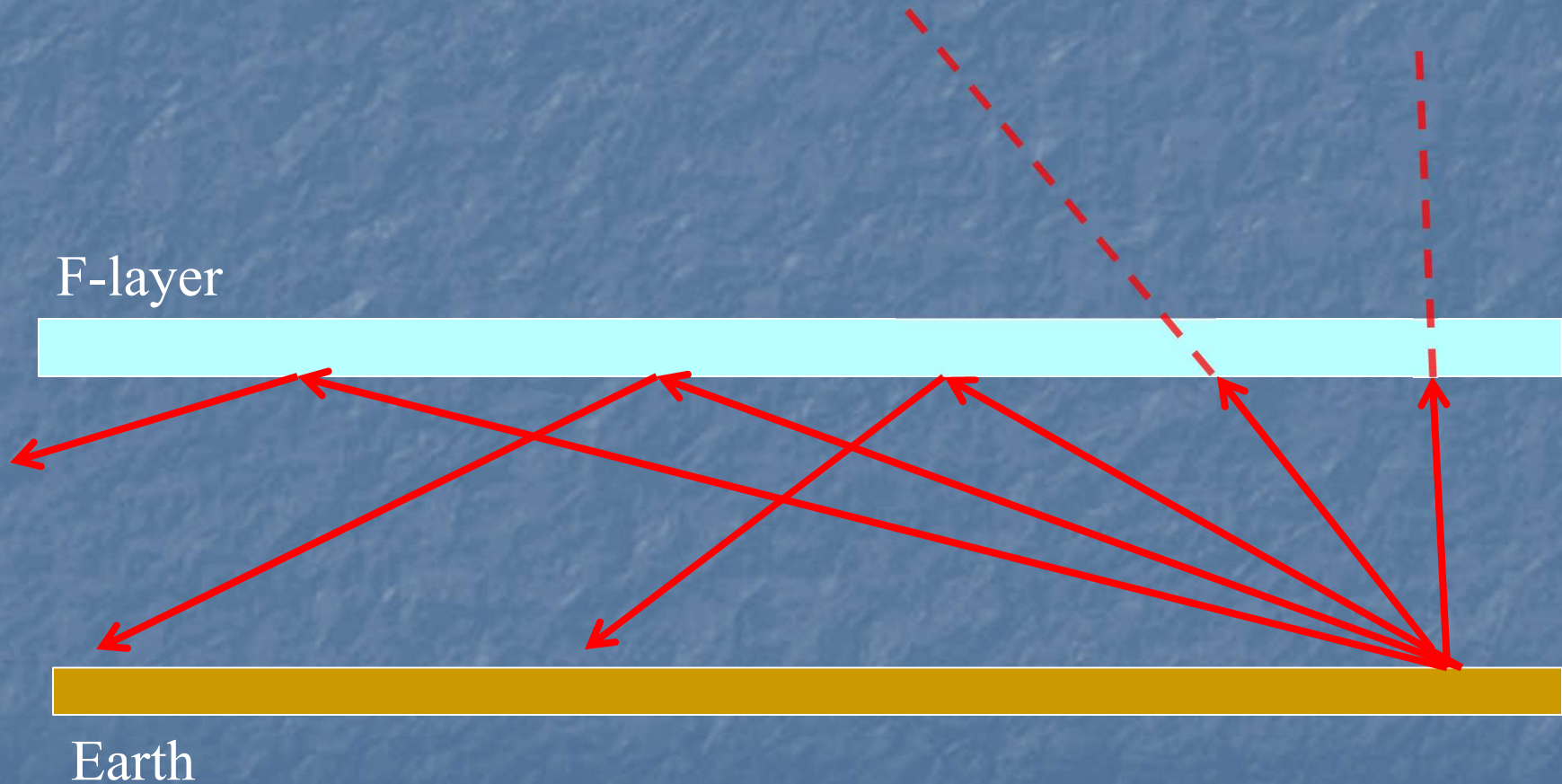
# Ten Meters



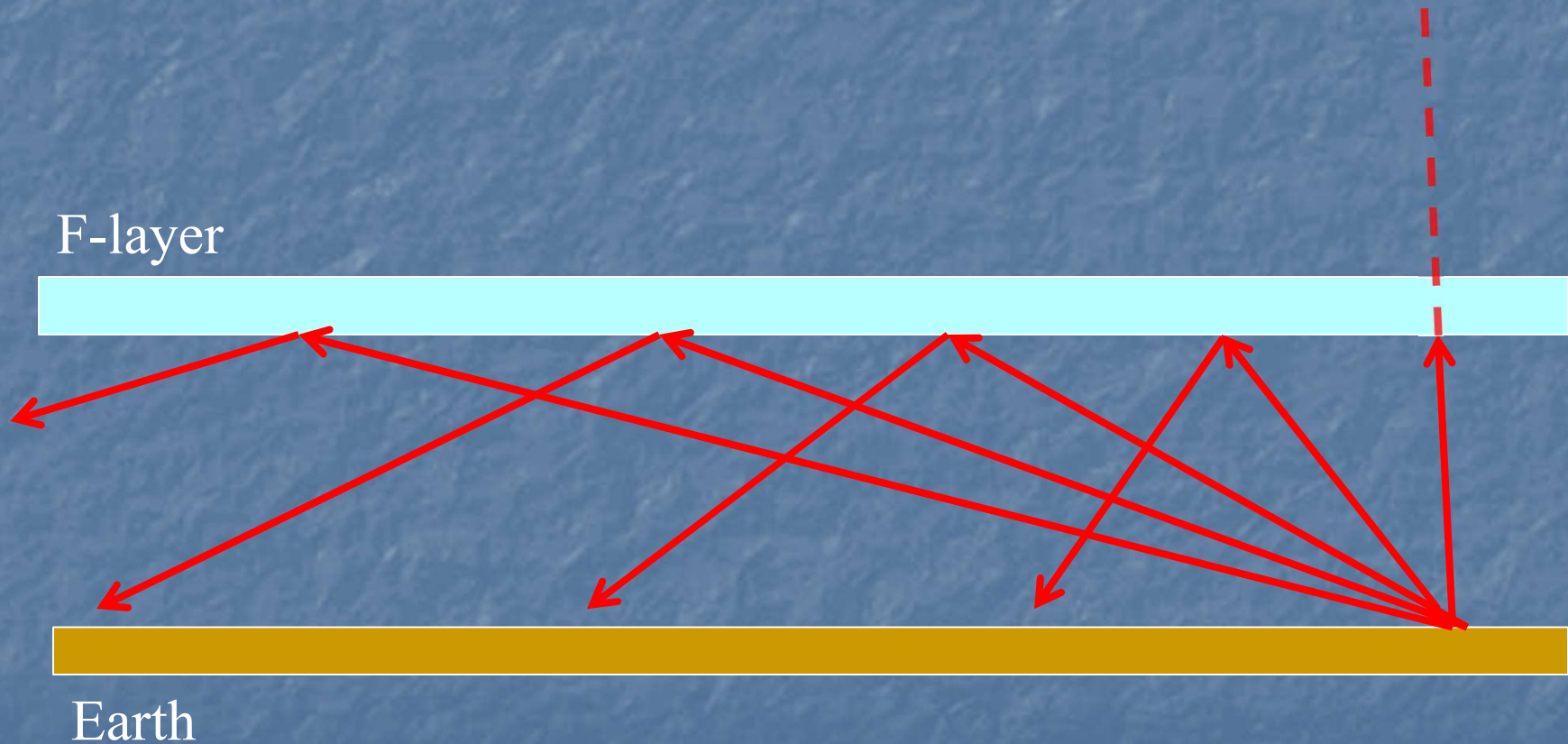
# Fifteen Meters



# Twenty Meters

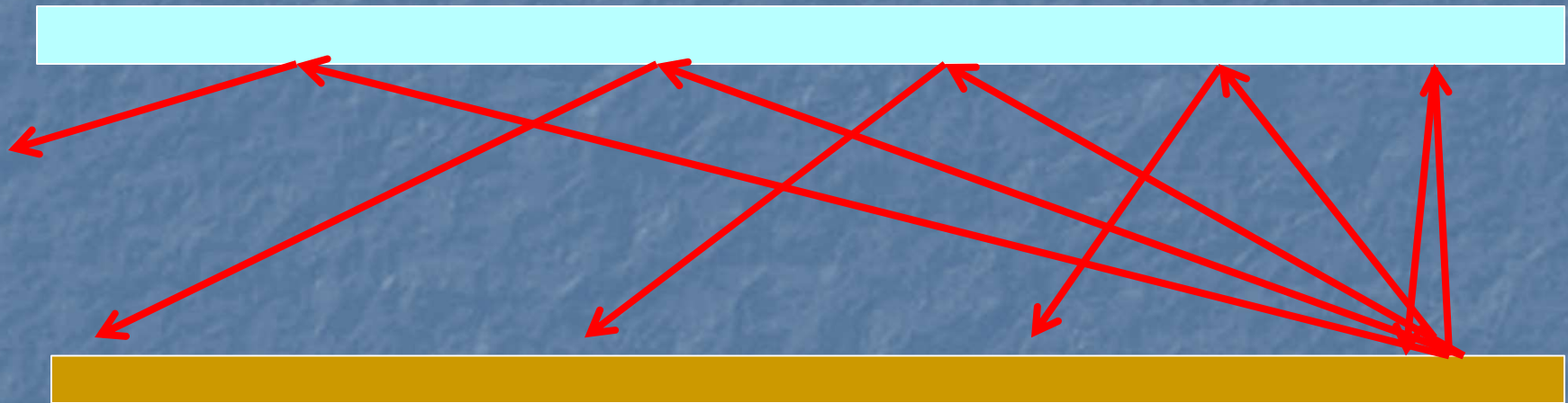


# Forty Meters



# Eighty Meters

F-layer



Earth

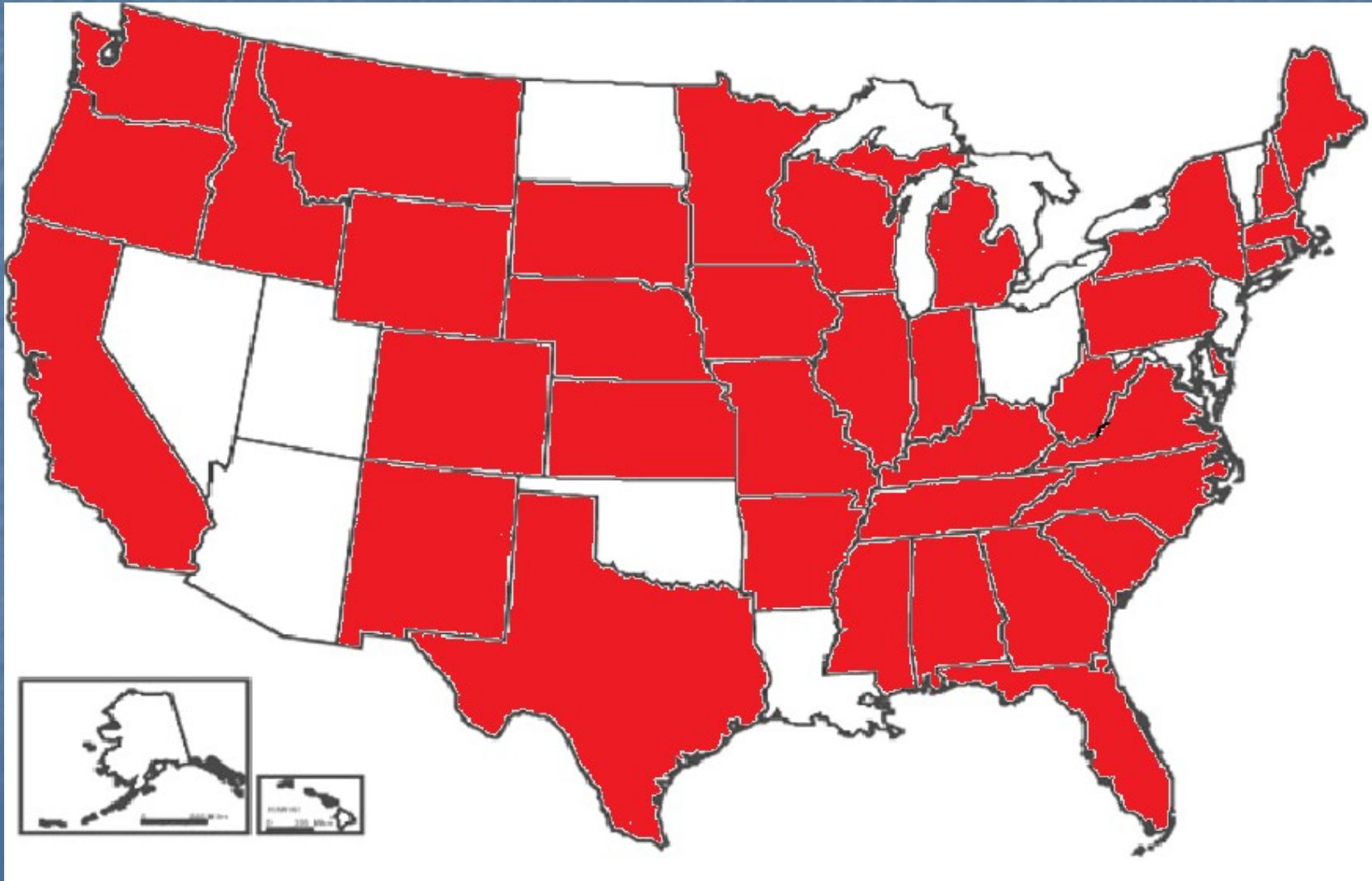
## So NVIS is not for the high bands

- 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

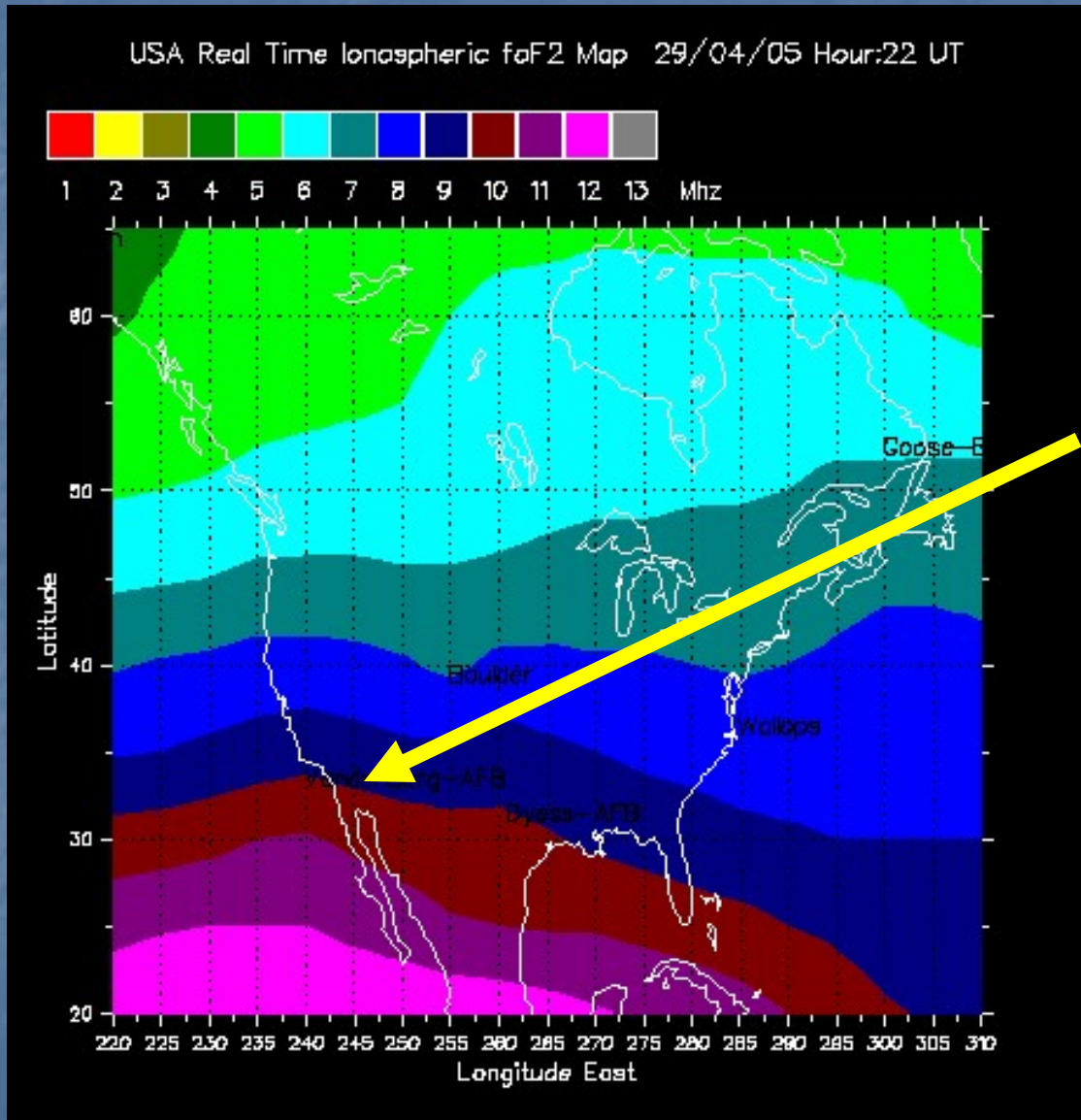


# K6D States Worked on 20 M in 2015 Cal QSO Party



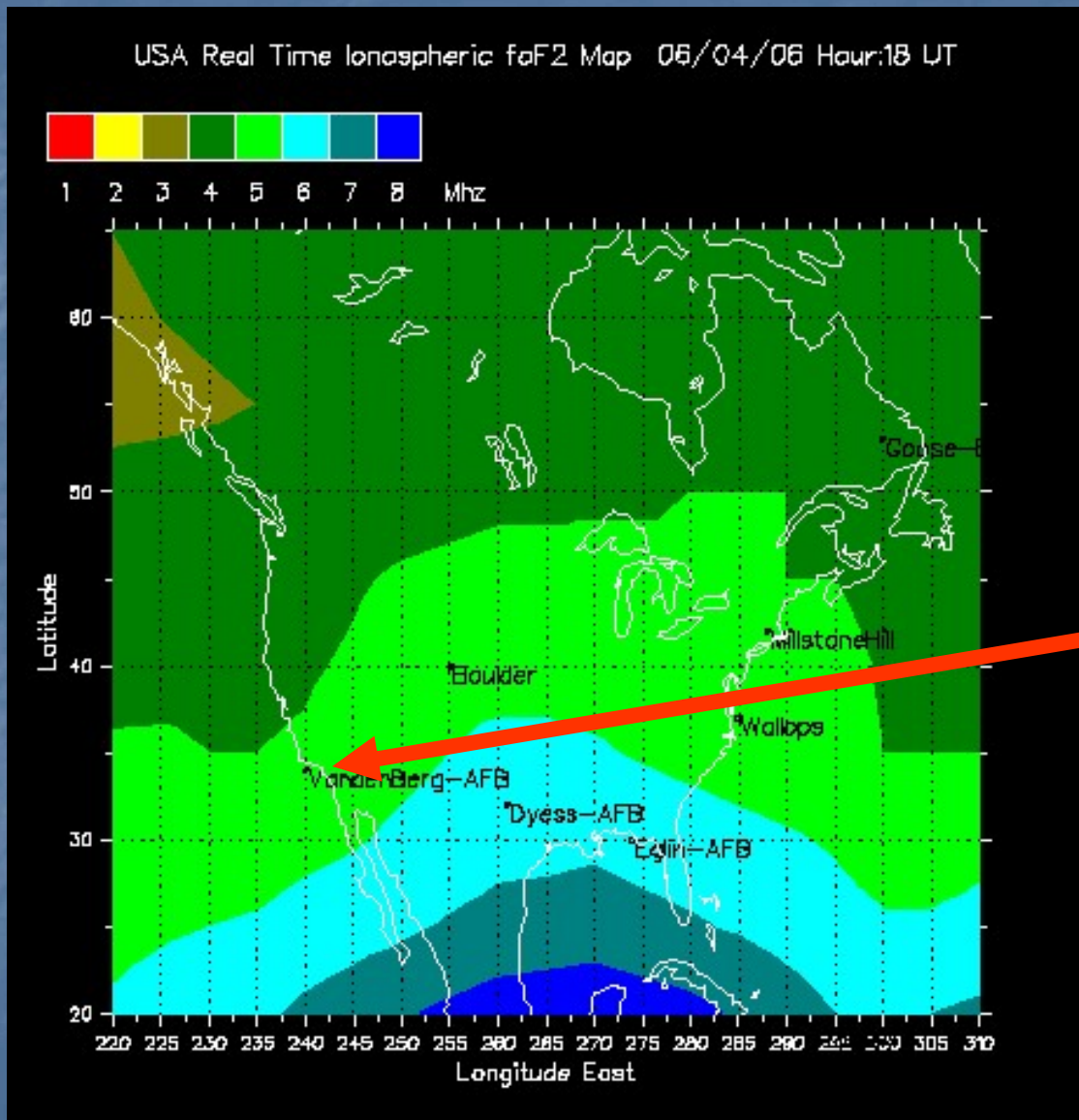
That leaves 160, 80, 60 and 40 meters

- Which band will give the best results?
- The optimum frequency varies by
  - time of day
  - time of year
  - where we are in the solar (sunspot) cycle
- Understanding this is the KEY to SUCCESS

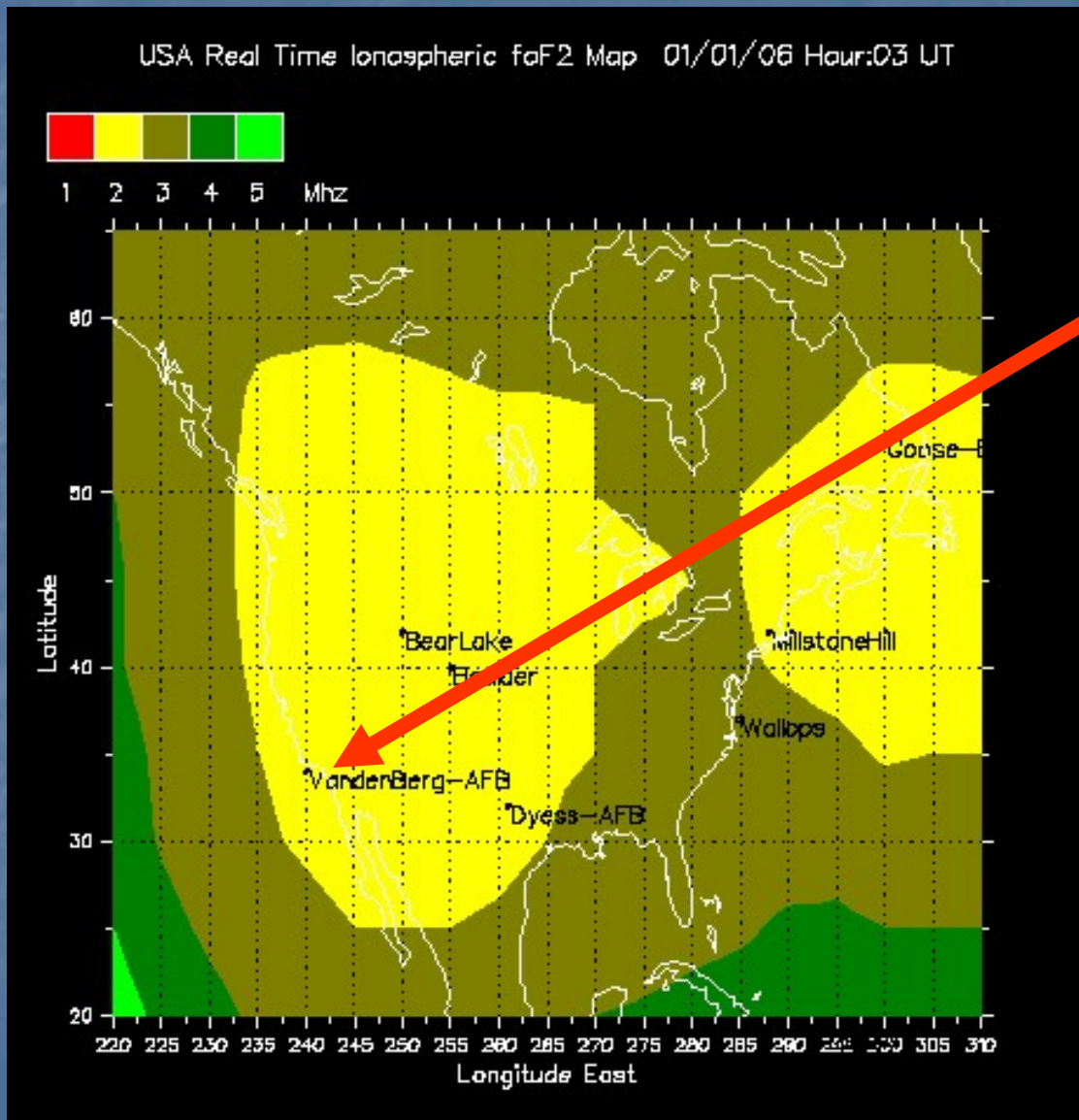


Here our critical frequency is close to 10 MHz. This was several years before the bottom of the last solar cycle.

**“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 low solar activity.

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

Q: If lower frequencies are more often below foF2, why not just use 160 meters all the time?

A: Because of the D-layer

## The D-layer: Low-band spoiler during daylight hours

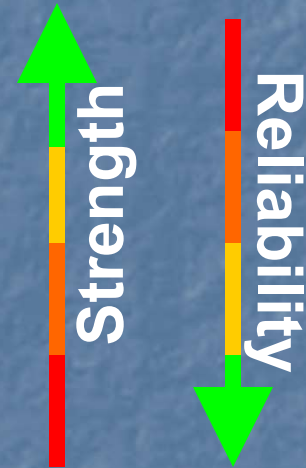
- The D layer lies below the F layer & E layer
- It absorbs RF signals when it's ionized (i.e., during the daytime); **it disappears at night!**

## The D-layer: Low-band spoiler during daylight hours

- 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 produce stronger signals UNTIL you reach foF2
- So pay attention to band selection, and plan on band changes during the course of a day!



# For regional communications now, it's days on 80, nights on 160

- This should 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.

To reach outside the region, look to 20m (day) and 40m (night)

- Greater distance = shallower skip angle
- Absorptive D-layer is less an issue
- Easier to get antennas to effective heights

# VHF + Advantages of SSB over FM

Lower duty cycle than FM – less system strain

Copy much weaker signals (i.e., better range)

Copy multiple callers clearly

And best of all . . .

**Plenty of room on the bands!**



# Voice capacity on two-meter band



**Room for over 60 SSB voice signals  
at the bottom end of the band!**



# Voice capacity on 70-centimeter band

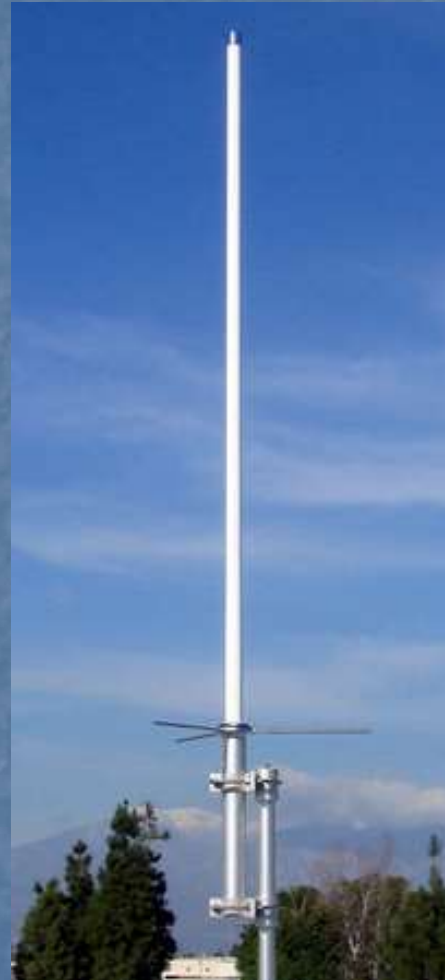
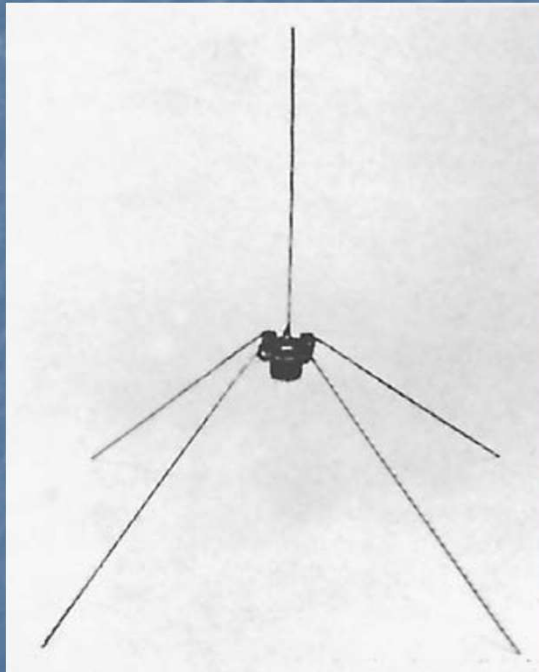


**Room for over 500 SSB voice signals  
in the weak-signal part of the band!**



# Antennas for VHF / UHF SSB

Your FM antenna will be fine for Emcomm work



# SSB and FM Practices Differ

FM channels are monitored or scanned

- squelch silences radio when no signals
- someone is either listening or not
- short call gets attention; no need to CQ



# SSB and FM Practices Differ

FM channels are monitored or scanned

- squelch silences radio when no signals
- someone is either listening or not
- short call gets attention; no need to CQ

SSB users tune across a range of frequencies

- squelch not used; band noise is audible
- others find you only if you are transmitting
- random contacts result from calling "CQ"



# SSB and FM Practices Differ

For FM nets, set-it-and-forget-it  
- being a few kHz off doesn't matter



# SSB and FM Practices Differ

For FM nets, set-it-and-forget-it

- being a few kHz off doesn't matter

For SSB nets, find and tune in Net Control

- not all frequency readouts are equal
- being a few kHz off means not being heard
- being slightly off frequency is noticeable



# Getting on VHF / UHF SSB

VHF / UHF only multi-mode transceivers - New

- Icom IC-9700 (2m, 70cm and 23cm bands)



# Getting on VHF / UHF SSB

VHF / UHF only multi-mode transceivers - Used

- Icom IC-271 / 371 / 275 / 375 / 475 (1-banders)
- Icom IC-970, IC-910H
- Yaesu FT-726; FT-736R
- Kenwood TS-770 / 780; TS-700 / 711 (2m only)



# Getting on VHF / UHF SSB

Multi-mode HF + VHF + UHF transceivers - New

- Icom IC-7100
- Icom IC-705 (10W ext. power / 5W int. batt)
- Yaesu FT-818, FT-991A



# Getting on VHF / UHF SSB

Multi-mode HF + VHF + UHF transceivers - Used

- Icom IC-706 (various models), IC-9100

- Yaesu FT-817, FT-857, FT-897

- Kenwood TS-2000



# Getting on VHF / UHF SSB

HF transceiver plus single-band transverter(s)

- Kuhne Electronic (Germany)
- Down East Microwave
- hfvhfparts (Ukraine)
- The Transverter Store
- Elecraft (used only)
- Microwave Modules and Ten-Tec (used only)



# HF Propagation for Emcomm

Thank You!

Marty Woll N6VI



Copyright 2020 N6VI