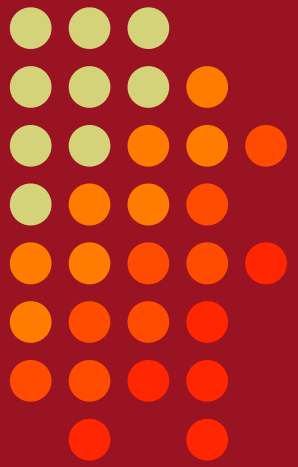
CTU Presents

2012 VHF Contesting

Joel Harrison, W5ZN



• CTU •
CONTEST
UNIVERSITY

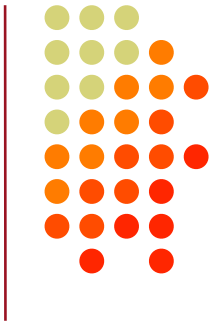
ICOM

This is a University so…….
Let's Start with a Test!

CTU
CONTEST
UNIVERSITY

ICOM

True or False?



- **I can't win a VHF contest unless I live in New England or on the east coast.**

  - K5UR Arkansas June 1987 – 1st Place Single-op
  - WB5IGF Arkansas June 1996 – New Single-op Record
  - W5ZN Arkansas June1998 – New Single-op Record
  - WA8WZG Ohio January 1999 – New Multi-op Record
  - WA8WZG Ohio January 2000 – New Multi-op Record
  - N5QGH Texas August 2000 – New Rover Record
  - W5ZN Arkansas August 2001 – First Place Single-op
  - K2DRH Iowa Multiple VHF Contests – Low Power Category
  - W5ZN Arkansas June 2011 – First Place Limited Multiop

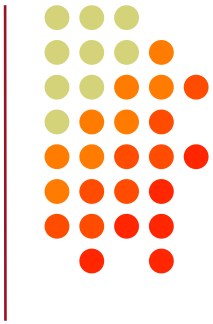
True or False?

- **You can't make a consistent 2 meter contact greater than ~100 miles.**
  - 70% are >100 miles. WSJT >500 miles
- **I can't be competitive unless I have 1500 watts and a large antenna array.**
  - K2DRH

CTU CONTEST UNIVERSITY

ICOM

Station Basics

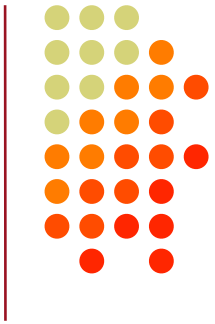


- **6 Meters**
  - Radio or transverter is fine
  - 50 watts is great, 100 watt is outstanding
  - 3 element antenna at 30 ft is good
- **2 Meters**
  - Radio or transverter is fine
  - >50 watts
  - 13 element beam @ ~50 ft

CTU CONTEST UNIVERSITY

ICOM

Station Basics

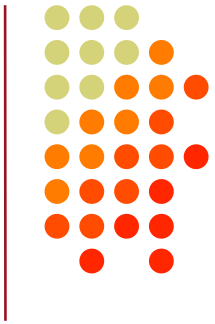


- **222 – 432 MHz**
  - >50 watts
  - 16 element & 25 element @ ~50 ft
  - Boom length
- **902 MHz & Up**
  - >10 watts
  - Loop yagis & parabolic (dish) antennas

CTU CONTEST UNIVERSITY

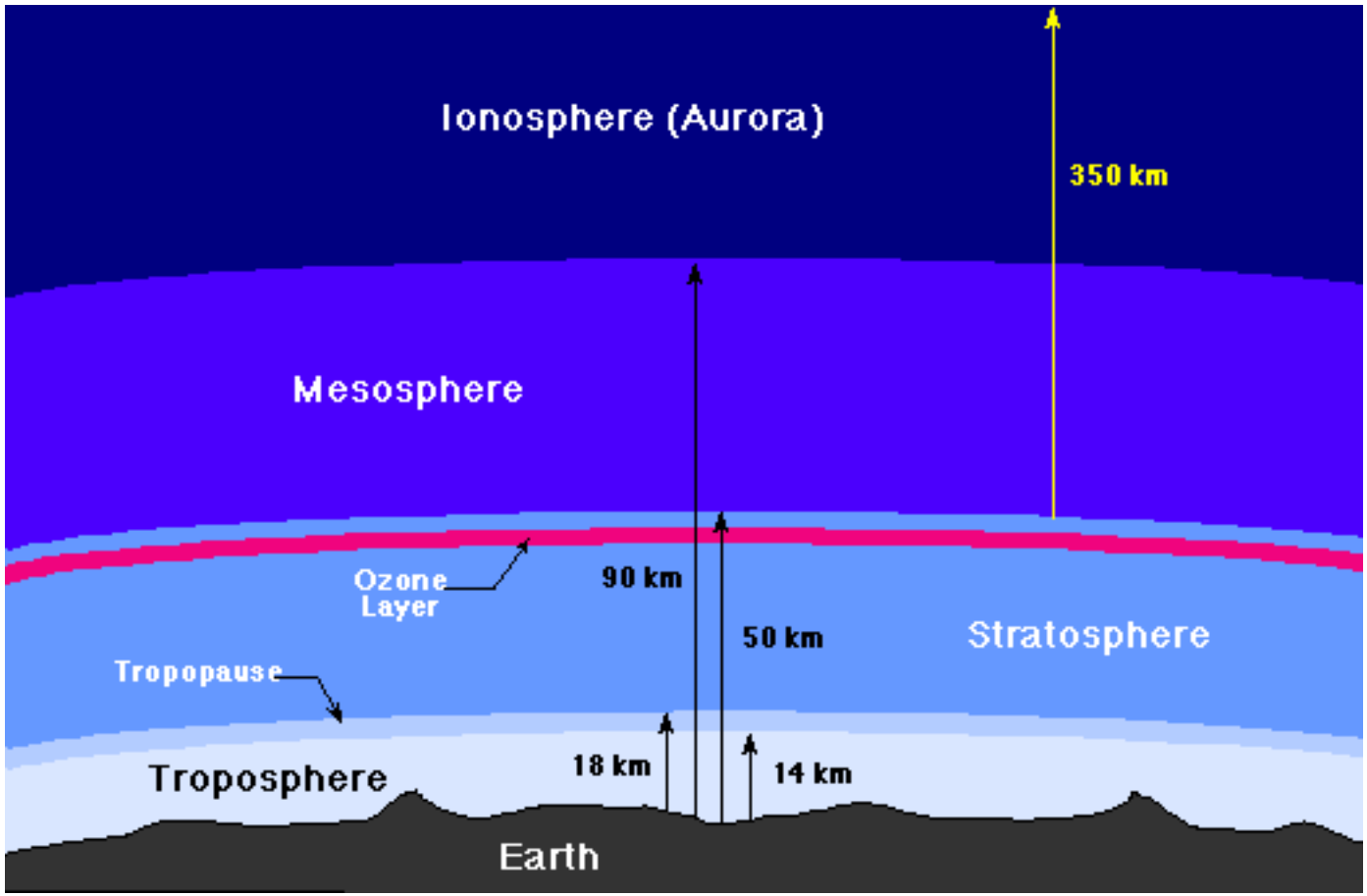
ICOM

Propagation



- Sporadic E – “Es”
- Tropospheric Ducting – “Tropo”
- Meteor Scatter – “MS”
- Aurora – “Au”
- Earth-Moon-Earth – “EME”

Propagation

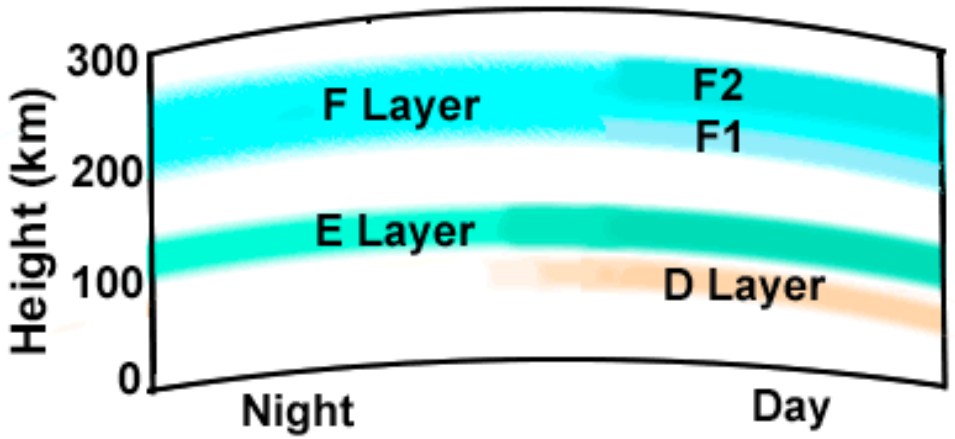


CTU CONTEST UNIVERSITY

ICOM

Propagation

At night the E layer and F layers are present. During the day, a D layer forms and the E and F layers become much stronger. Often during the day the F layer will divide into F1 and F2 layers.



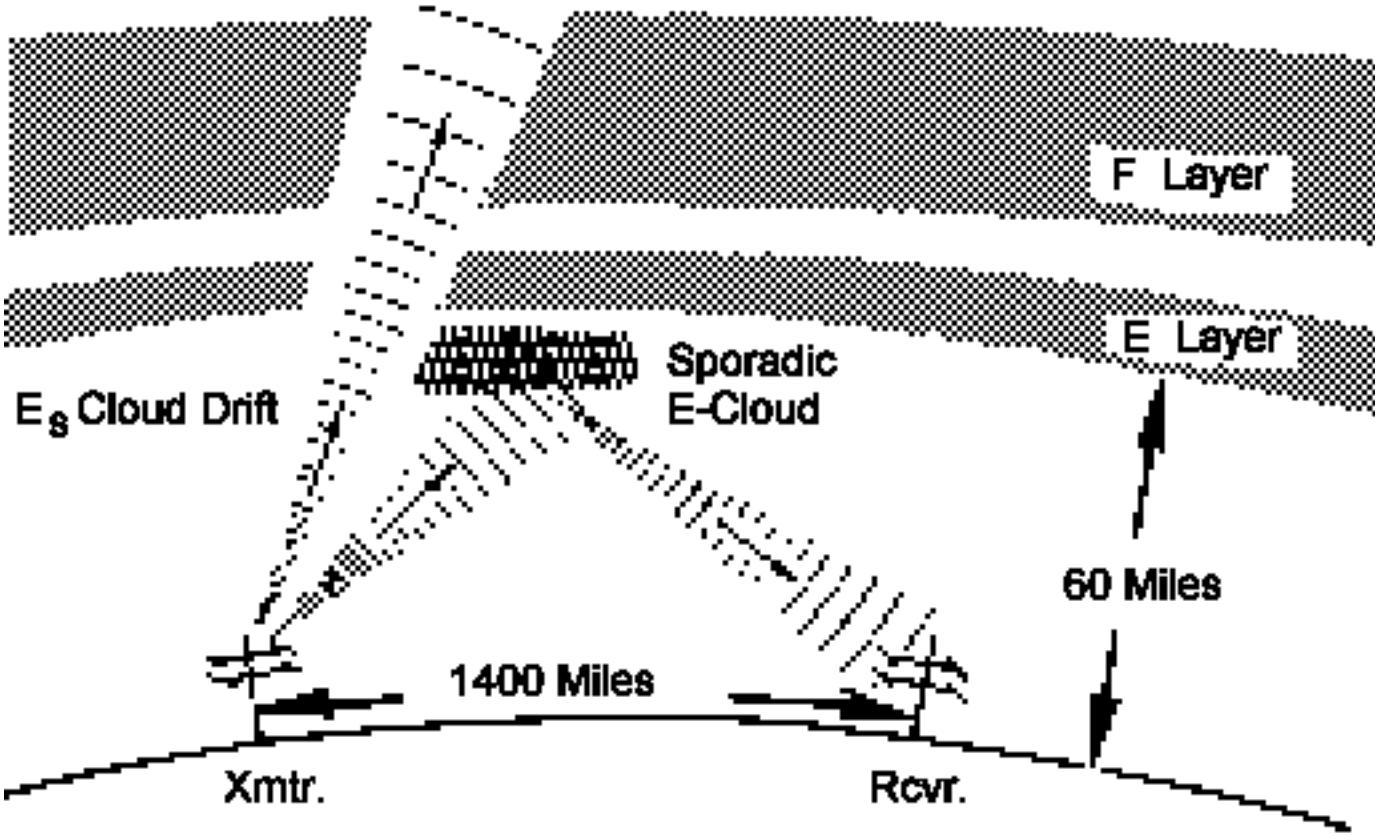
CTU CONTEST UNIVERSITY

ICOM

Propagation – Es

- **Sporadic ionization of the E-Layer**
  - Peaks May–July, Possibly generated by lightning
- **50 & 144 MHz, possibly 222 MHz**
  - Single-hop optimum range 900-1300 miles, maximum range 1350-1500 miles
  - Double-hop optimum range 2000-2600 miles, maximum range 2750-3100 miles
- **Peak time during daylight hours & early evening**

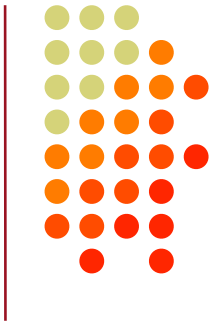
Propagation – Es



CTU
CONTEST
UNIVERSITY

ICOM

Propagation - Tropo

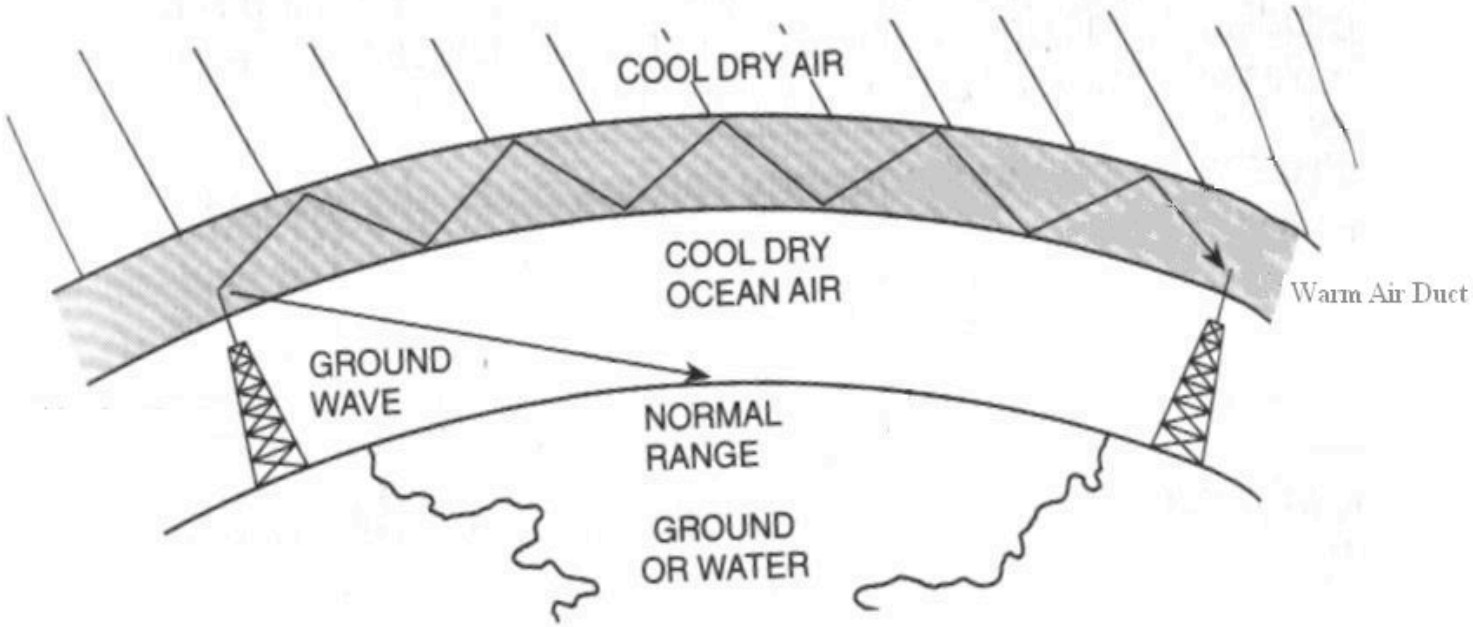


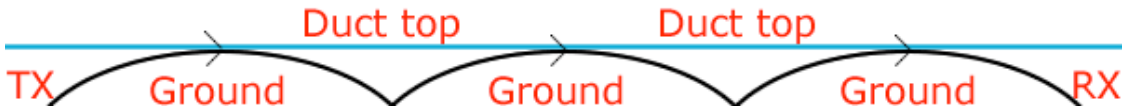
- **Natural atmospheric ducts that form due to temperature inversion and can shuffle VHF and UHF radio waves long distances**
  - All bands
  - Any time, but mostly warm weather months
    - January – WA8WZG / W5ZN Path
    - The famous “California-Hawaii Duct”

CTU CONTEST UNIVERSITY

ICOM

Propagation - Tropo

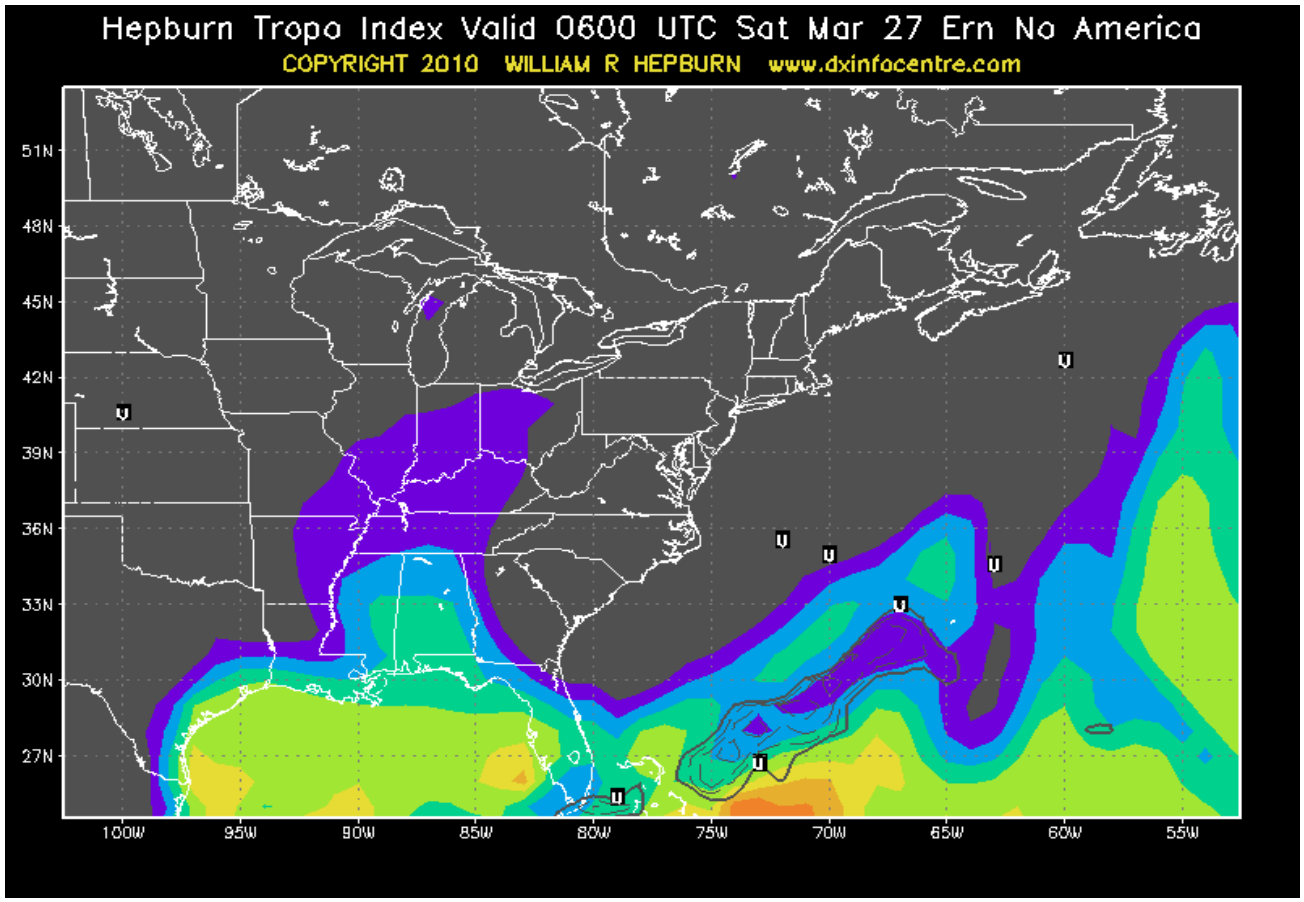




CTU CONTEST UNIVERSITY

ICOM

Propagation - Tropo

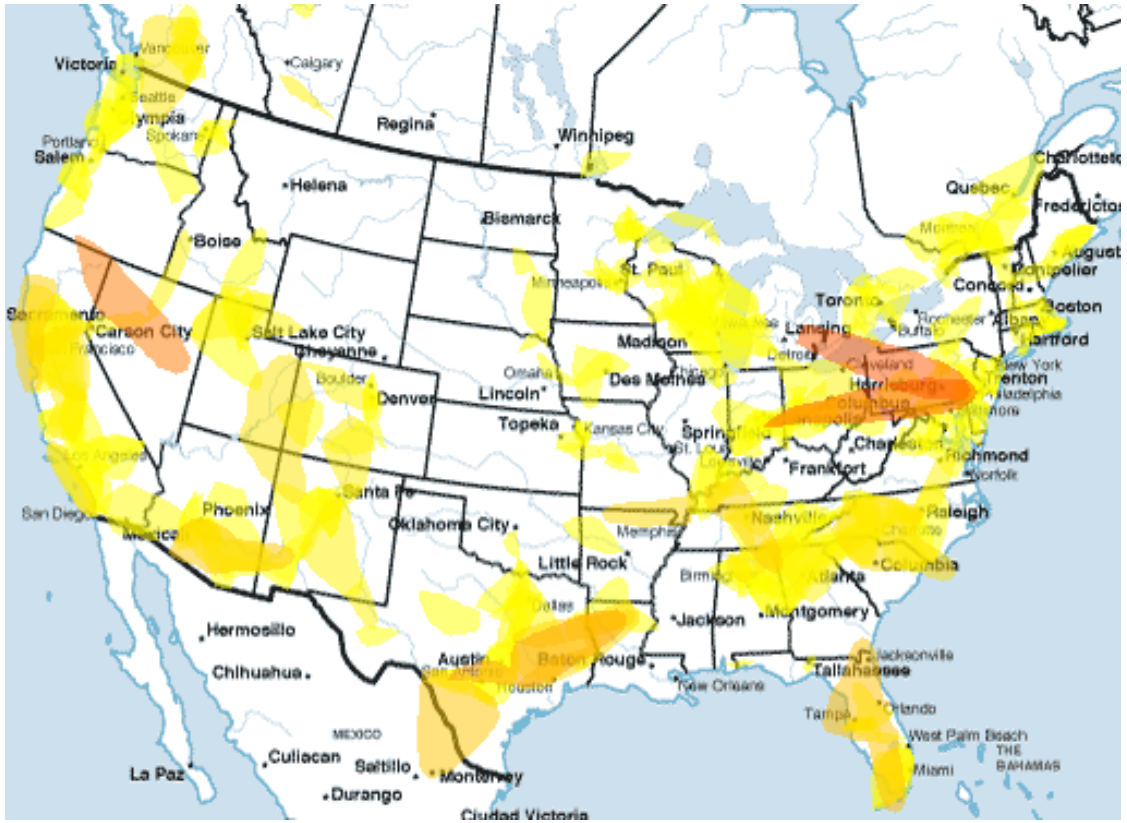


CTU CONTEST UNIVERSITY

ICOM

Propagation - Tropo

APRS VHF Propagation Map

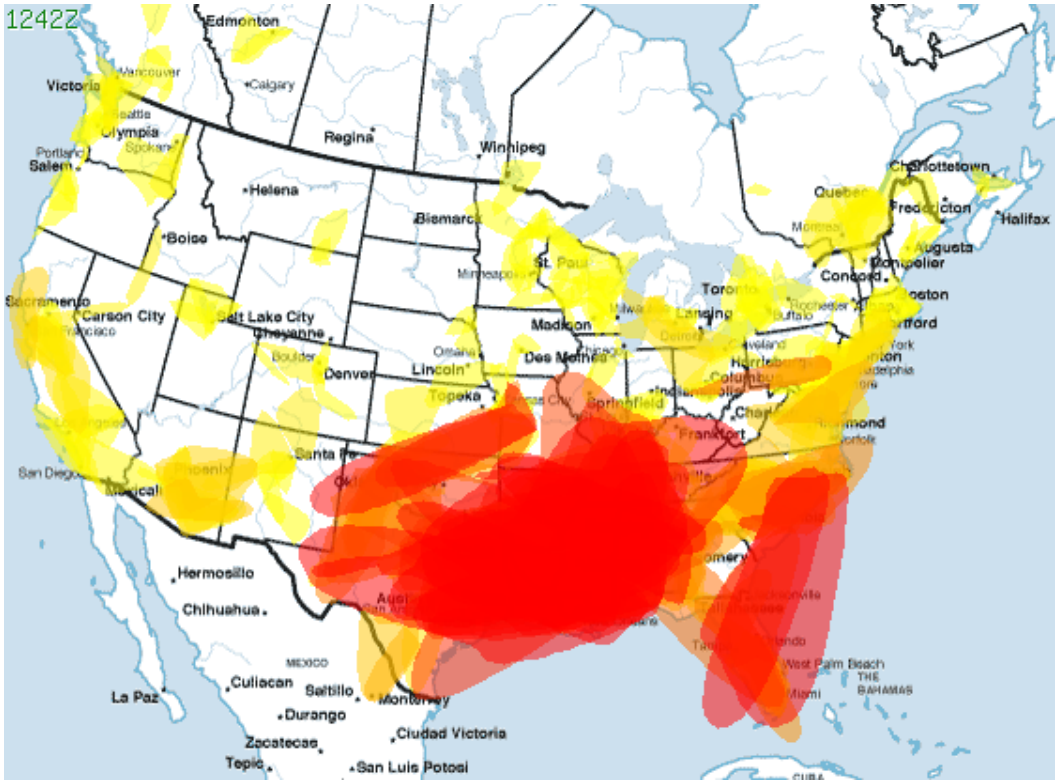


CTU CONTEST UNIVERSITY

ICOM

Propagation - Tropo

APRS VHF Propagation Map



"Holy Crap!!!!"

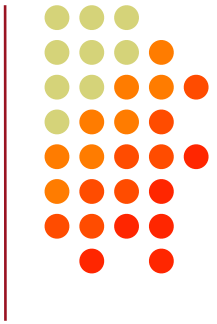
- KX9X

Major tropo opening

CTU CONTEST UNIVERSITY

ICOM

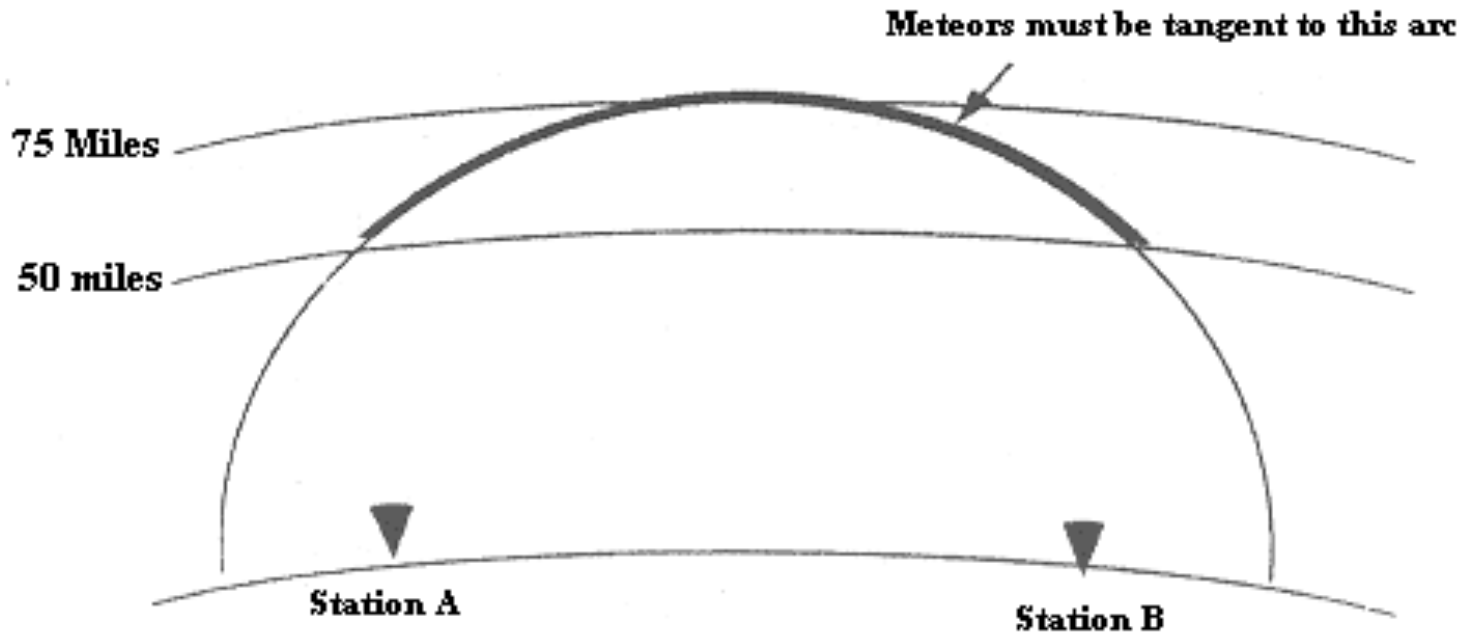
Propagation – MS



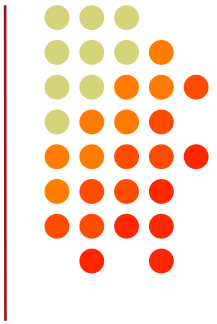
- Meteor scatter is the reflection of radio waves from the ionized trails from meteors burning up in the upper atmosphere.
- Meteors burn up in the upper atmosphere at a height of around 65 miles.
- This may be used to make QSOs up to about 1400 miles

Propagation – MS

Reflection will occur when the trail is oriented as shown



Propagation – MS



- **Excellent for 50 & 144 MHz, possible at 222 MHz**
- **Very Predictable Paths**
  - Best times between midnight & approx 9 AM
  - Peak during “showers” – Anytime with high speed procedures like WSJT

Propagation - Au

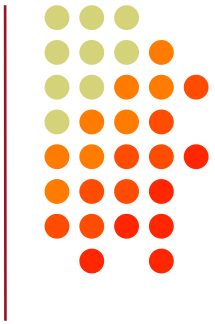
- The Aurora Borealis is caused by charged particles from the magnetosphere.

- Bottom edge is typically 60 miles altitude & extends over a very large range

Propagation - Au

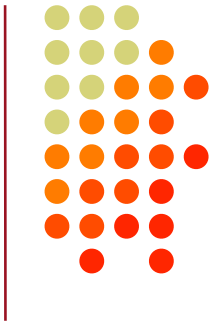
- Acts as a reflective curtain to radio waves
- The reflected wave is very distorted and CW signals are very raspy. Report = 5-9-A
- Not predictable. Possible with K index >5
- Both station antennas north toward aurora
- *Very Rare during VHF contests*

Propagation - EME



- Moon is used as a passive reflector
- Available anytime you have a common moon with the station you wish to contact
- Requires special skills, techniques & equipment
- *Used in VHF contests to beef up multipliers*

Noise



- **Internet Routers can be a significant noise source at VHF that can populate the band**
  - **Multiple carriers of relatively constant amplitude but with modulation (Birdies)**
  - ***Br*oadband trash**

Noise

The Grim Reaper of noise is *not* your friend!!

- Sky Noise

- Atmospheric Noise

- Line Noise

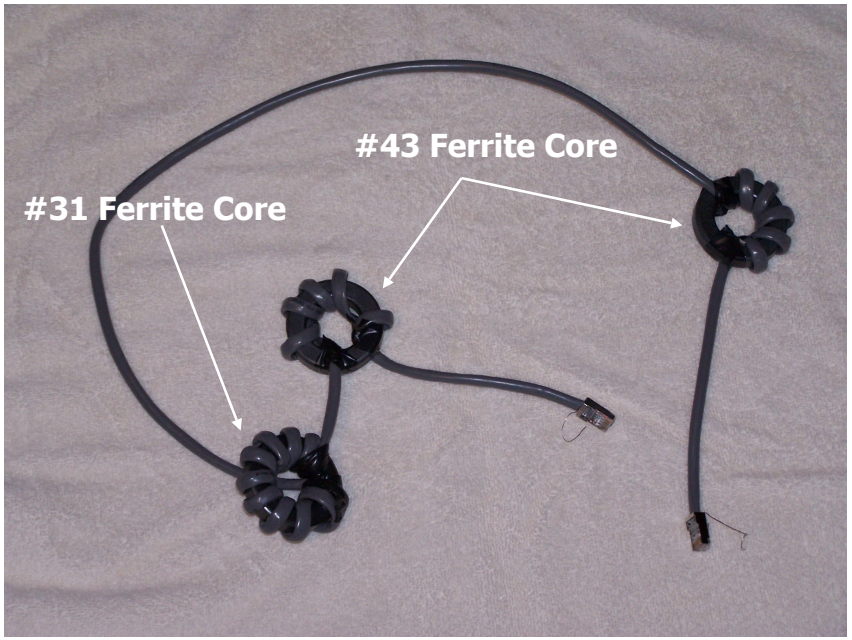
- Other man-made noise

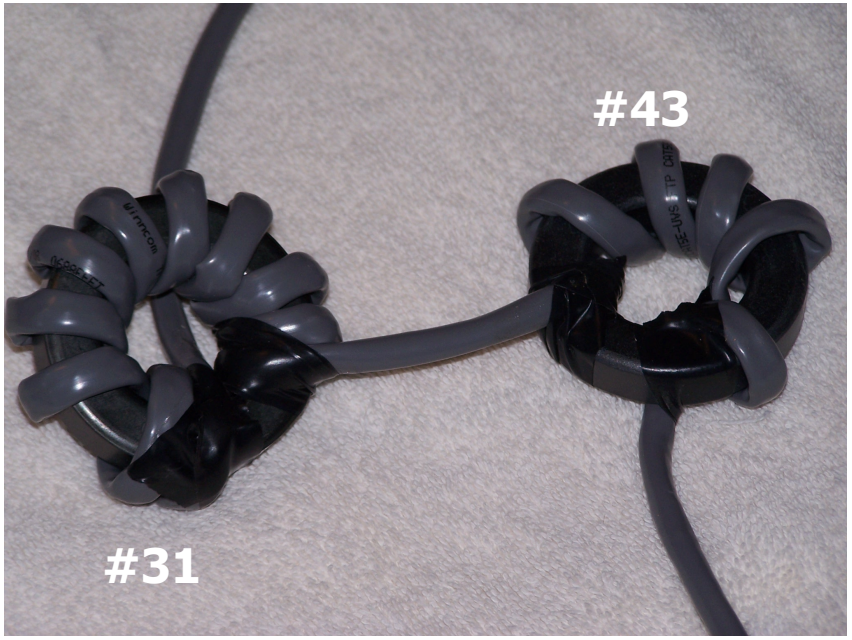
CTU CONTEST UNIVERSITY

ICOM

Noise

- Internet Router noise can be significantly reduced or eliminated



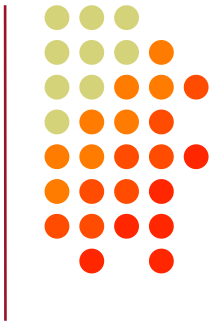


Shielded CAT5 cable and connectors can help

CTU CONTEST UNIVERSITY

ICOM

Equipment

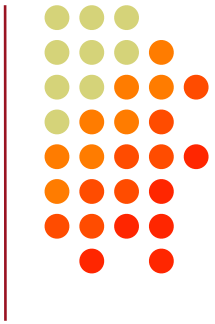


- Antennas
- Receive Preamplifiers
- Amplifiers
- Radios
- Transverters

CTU
CONTEST
UNIVERSITY

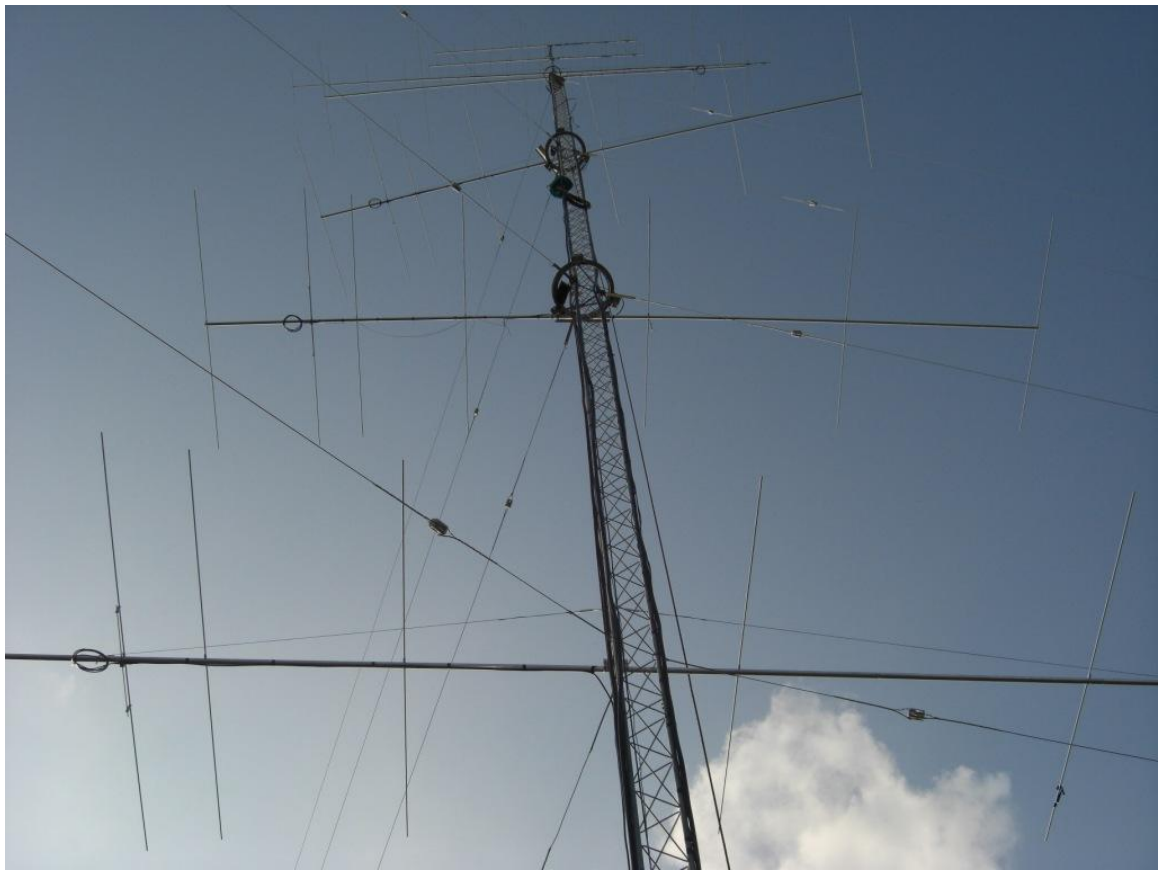
ICOM

Equipment - Antennas



- VHF antennas are small in comparison to HF antennas
- Boom lengths can be large, 30’ to 50’, but elements length & diameter is much smaller
- Antenna stacking for added gain is much easier at VHF

Equipment - Antennas



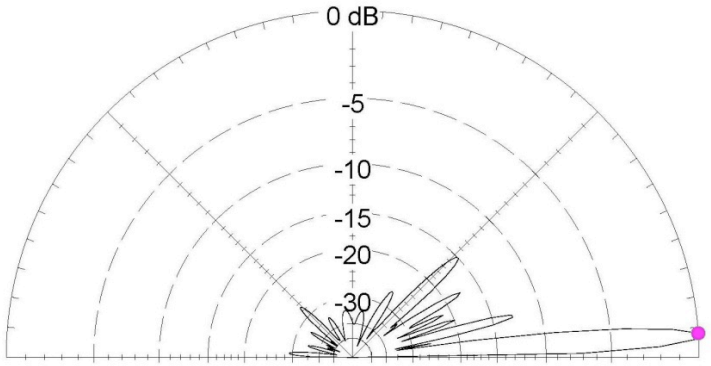
7x7x7x7 50 MHz Array at W5ZN

CTU CONTEST UNIVERSITY

ICOM

Equipment - Antennas

Total Field EZNEC+



Five-element Yagi 50.1 MHz

Elevation Plot		Cursor Elev	4.0 deg.
Azimuth Angle	0.0 deg.	Gain	22.84 dBi
Outer Ring	22.84 dBi		0.0 dBmax
Slice Max Gain	22.84 dBi @ Elev Angle = 4.0 deg.		
Beamwidth	3.8 deg.; -3dB @ 1.8, 5.6 deg.		
Sidelobe Gain	10.1 dBi @ Elev Angle = 14.0 deg.		
Front/Sidelobe	12.74 dB		

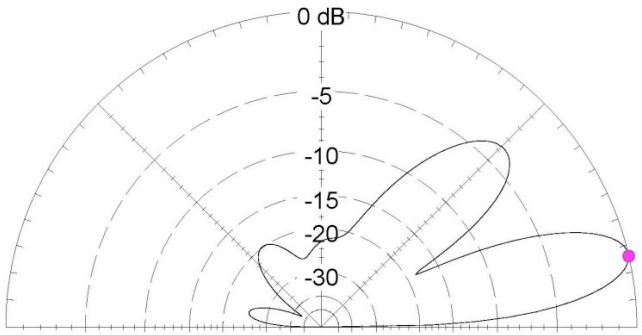
7x7x7x7 Array of 50 MHz Antennas 30 ft Boom – 102’ total height

CTU CONTEST UNIVERSITY

ICOM

Equipment - Antennas

Total Field EZNEC+

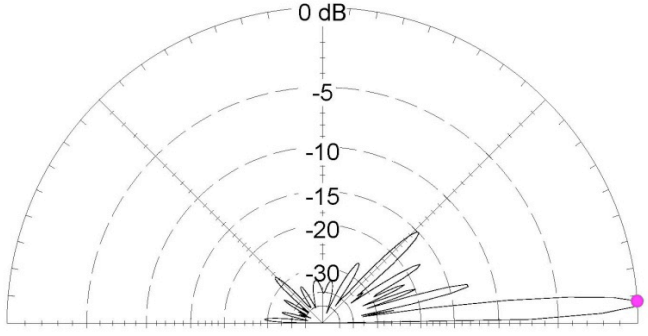


50 MHz - Three Element Yagi 50.1 MHz

Elevation Plot		Cursor Elev	13.0 deg.
Azimuth Angle	0.0 deg.	Gain	13.53 dBi
Outer Ring	13.53 dBi		0.0 dBmax
Slice Max Gain	13.53 dBi @ Elev Angle = 13.0 deg.		
Beamwidth	14.3 deg.; -3dB @ 6.6, 20.9 deg.		
Sidelobe Gain	9.89 dBi @ Elev Angle = 44.0 deg.		
Front/Sidelobe	3.64 dB		

Single 3 element @ 20ft

Total Field EZNEC+



7x7x7x7 Array 50.1 MHz

Elevation Plot		Cursor Elev	4.0 deg.
Azimuth Angle	0.0 deg.	Gain	22.84 dBi
Outer Ring	22.84 dBi		0.0 dBmax
Slice Max Gain	22.84 dBi @ Elev Angle = 4.0 deg.		
Beamwidth	3.8 deg.; -3dB @ 1.8, 5.6 deg.		
Sidelobe Gain	10.1 dBi @ Elev Angle = 14.0 deg.		
Front/Sidelobe	12.74 dB		

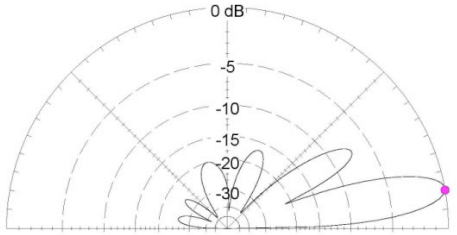
7x7x7x7 Array

CTU CONTEST UNIVERSITY

ICOM

Equipment - Antennas

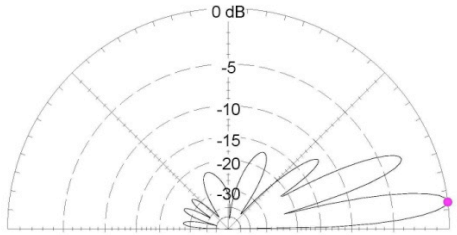
Total Field EZNEC+



7 Element Yagi @ 25 FT 50.1 MHz

Elevation Plot		Cursor Elev	10.0 deg.
Azimuth Angle	0.0 deg.	Gain	17.98 dBi
Outer Ring	17.98 dBi		0.0 dBmax
Slice Max Gain	17.98 dBi @ Elev Angle = 10.0 deg.		
Beamwidth	11.1 deg.; -3dB @ 5.1, 16.2 deg.		
Sidelobe Gain	10.86 dBi @ Elev Angle = 32.0 deg.		
Front/Sidelobe	7.12 dB		

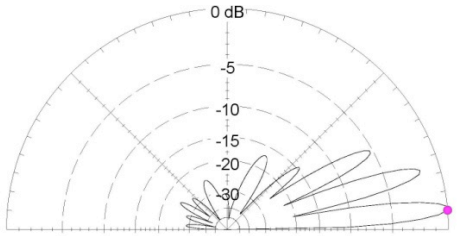
Total Field EZNEC+



7 Element Yagi @ 37.5 FT 50.1 MHz

Elevation Plot		Cursor Elev	7.0 deg.
Azimuth Angle	0.0 deg.	Gain	18.42 dBi
Outer Ring	18.42 dBi		0.0 dBmax
Slice Max Gain	18.42 dBi @ Elev Angle = 7.0 deg.		
Beamwidth	7.4 deg.; -3dB @ 3.6, 11.0 deg.		
Sidelobe Gain	15.52 dBi @ Elev Angle = 22.0 deg.		
Front/Sidelobe	2.9 dB		

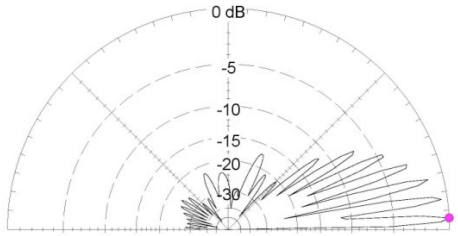
Total Field EZNEC+



7 Element Yagi @ 50 FT 50.1 MHz

Elevation Plot		Cursor Elev	5.0 deg.
Azimuth Angle	0.0 deg.	Gain	18.53 dBi
Outer Ring	18.53 dBi		0.0 dBmax
Slice Max Gain	18.53 dBi @ Elev Angle = 5.0 deg.		
Beamwidth	5.6 deg.; -3dB @ 2.7, 8.3 deg.		
Sidelobe Gain	16.95 dBi @ Elev Angle = 17.0 deg.		
Front/Sidelobe	1.58 dB		

Total Field EZNEC+



7 Element Yagi @ 100 FT 50.1 MHz

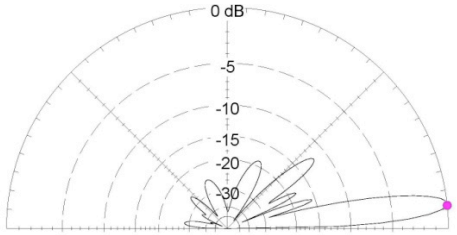
Elevation Plot		Cursor Elev	3.0 deg.
Azimuth Angle	0.0 deg.	Gain	18.72 dBi
Outer Ring	18.72 dBi		0.0 dBmax
Slice Max Gain	18.72 dBi @ Elev Angle = 3.0 deg.		
Beamwidth	2.6 deg.; -3dB @ 1.5, 4.1 deg.		
Sidelobe Gain	18.23 dBi @ Elev Angle = 8.0 deg.		
Front/Sidelobe	0.49 dB		

CTU CONTEST UNIVERSITY

ICOM

Equipment - Antennas

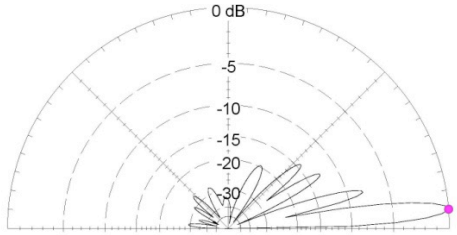
Total Field EZNEC+



Two 7 ele. Yagis @ 25' & 50' 50.1 MHz

Elevation Plot		Cursor Elev	6.0 deg.
Azimuth Angle	0.0 deg.	Gain	20.33 dBi
Outer Ring	20.33 dBi		0.0 dBmax
Slice Max Gain	20.33 dBi @ Elev Angle = 6.0 deg.		
Beamwidth	7.0 deg.; -3dB @ 3.2, 10.2 deg.		
Sidelobe Gain	8.46 dBi @ Elev Angle = 39.0 deg.		
Front/Sidelobe	11.87 dB		

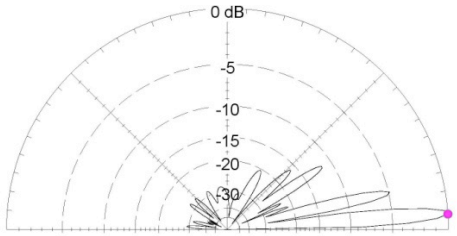
Total Field EZNEC+



Two 7 ele Yagis @ 37' & 62' 50.1 MHz

Elevation Plot		Cursor Elev	5.0 deg.
Azimuth Angle	0.0 deg.	Gain	20.97 dBi
Outer Ring	20.97 dBi		0.0 dBmax
Slice Max Gain	20.97 dBi @ Elev Angle = 5.0 deg.		
Beamwidth	5.4 deg.; -3dB @ 2.6, 8.0 deg.		
Sidelobe Gain	13.04 dBi @ Elev Angle = 15.0 deg.		
Front/Sidelobe	7.93 dB		

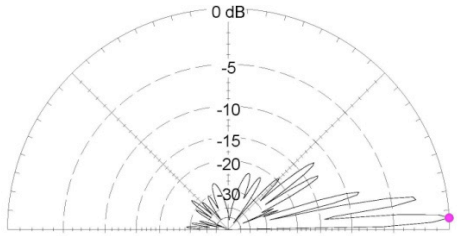
Total Field EZNEC+



Two 7 ele Yagis @ 50' & 75' 50.1 MHz

Elevation Plot		Cursor Elev	4.0 deg.
Azimuth Angle	0.0 deg.	Gain	21.24 dBi
Outer Ring	21.24 dBi		0.0 dBmax
Slice Max Gain	21.24 dBi @ Elev Angle = 4.0 deg.		
Beamwidth	4.3 deg.; -3dB @ 2.1, 6.4 deg.		
Sidelobe Gain	16.37 dBi @ Elev Angle = 13.0 deg.		
Front/Sidelobe	4.87 dB		

Total Field EZNEC+



Two 7 ele Yagis @ 75' & 100' 50.1 MHz

Elevation Plot		Cursor Elev	3.0 deg.
Azimuth Angle	0.0 deg.	Gain	21.56 dBi
Outer Ring	21.56 dBi		0.0 dBmax
Slice Max Gain	21.56 dBi @ Elev Angle = 3.0 deg.		
Beamwidth	2.9 deg.; -3dB @ 1.7, 4.6 deg.		
Sidelobe Gain	18.94 dBi @ Elev Angle = 9.0 deg.		
Front/Sidelobe	2.62 dB		

CTU CONTEST UNIVERSITY

ICOM

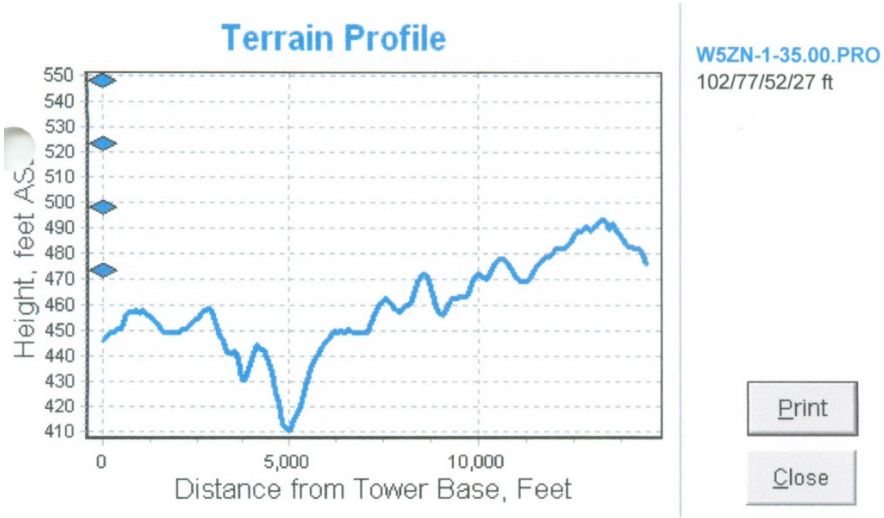
Equipment - Antennas

HFTA

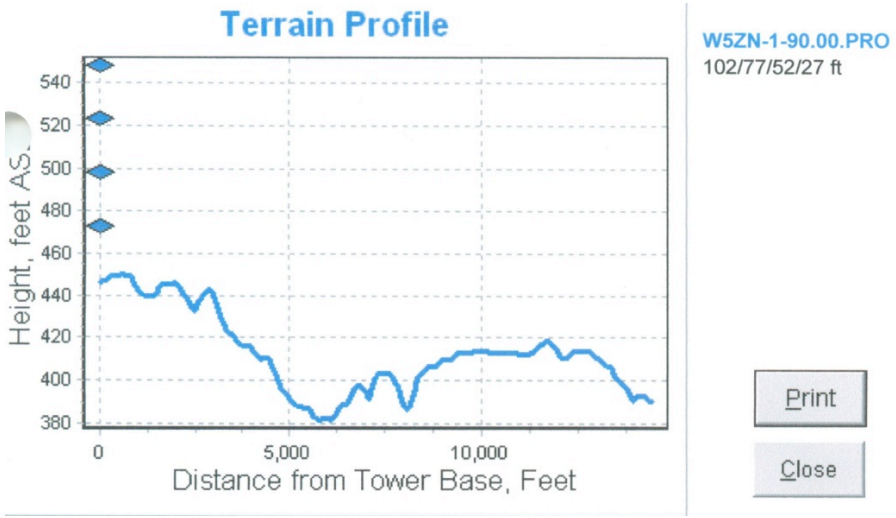
- **Terrain analysis works for 50 MHz**
- **Elevation angle statistics may not be accurate**
  - Based on IONCAP/VOACAP which are only accurate up to 30 MHz

Equipment - Antennas

HFTA



35º Beam Heading – 4 Antennas

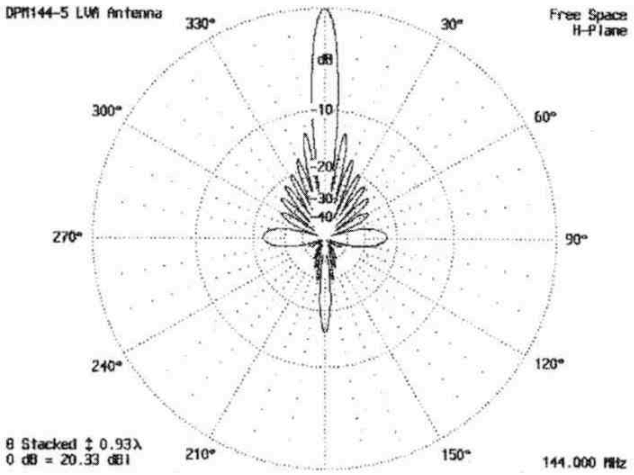


90º Beam Heading – 4 Antennas

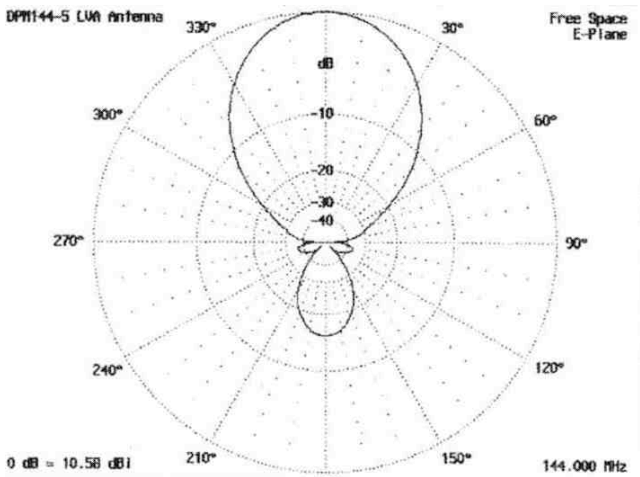
CTU CONTEST UNIVERSITY

ICOM

Equipment - Antennas



H-Plane Pattern



E-Plane Pattern

2 Meter 144LVA

5x5x5x5x5x5x5x5

CTU CONTEST UNIVERSITY

ICOM

Equipment - Antennas

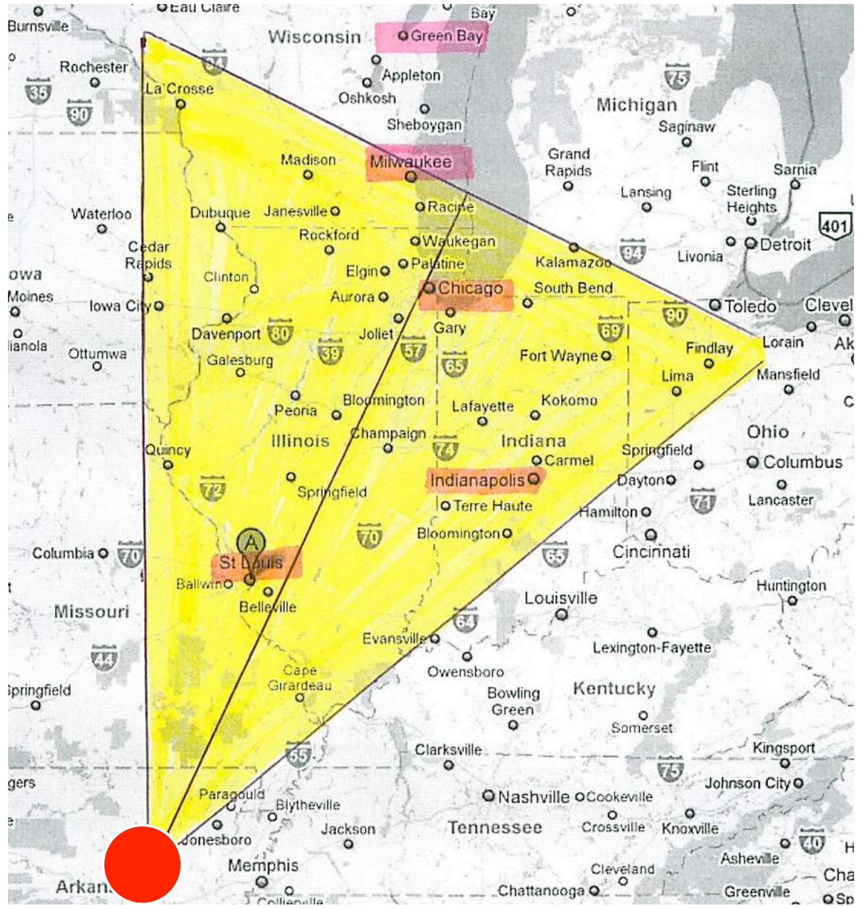
Major Metropolitan Areas Covered with 144LVA from W5ZN:

St. Louis

Indianapolis

Chicago

Milwaukee

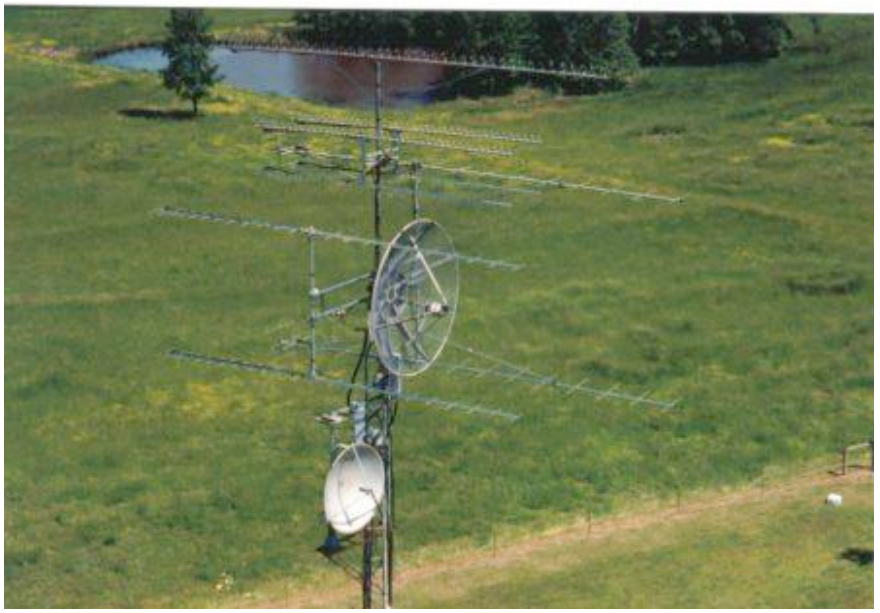


W5ZN

CTU CONTEST UNIVERSITY

ICOM

Equipment - Antennas



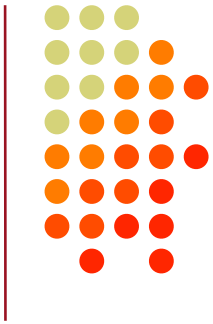
Stacking is easy for UHF/Microwave antennas

8 Band Array – 222 MHz thru 10 GHz

CTU CONTEST UNIVERSITY

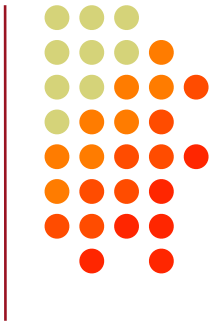
ICOM

Equipment - Receive Preamps



- **You do *NOT* need a preamp just because:**
  - You “think” you do
  - Your ham buddy that you “think” is an authority on the subject told you so!
- **LEARN ABOUT SYSTEM NOISE FIGURES!**
  - Don’t rely on someone else’s assumed judgment
  - What will a preamp actually do when you add it to the line?

Equipment - Receive Preamps

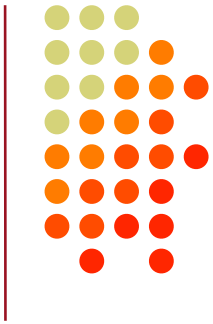


- Preamp is not needed unless your receiver has a really bad noise figure
- What is a “bad” noise figure??
  - Total system noise figure depends more on antenna & sky temperature – they will dominate & you can’t change them
- At VHF and above, gain is NOT as important as a low noise figure

CTU CONTEST UNIVERSITY

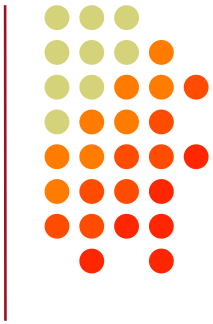
ICOM

Equipment - Receive Preamps



- Assume T_{ant} = 3000°K
- If RX nf is 20 dB and you add a preamp with only 12 dB gain but it's nf is 2 dB you will improve your system nf by 10 dB!
- If RX nf is 10 db and you add a preamp with 25 dB gain but it's nf is 10 dB you will improve by 0 dB and cause other problems.

Equipment - Receive Preamps



RX Noise figure (nf) to Noise Factor (NF)

$$10^{\frac{nf\ (db)}{\text{Inv Log}}}$$

Noise Factor to Temp (K) = NF - 1 x 290

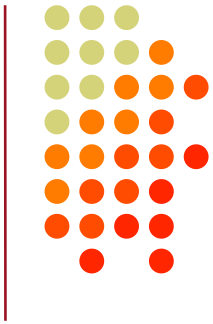
Total System Temp = T_{ANT} + T_{RX}

$$\text{Improvement (dB)} = 10 \log \frac{\text{Temp 1}}{\text{Temp 2}}$$

CTU CONTEST UNIVERSITY

ICOM

Equipment - Receive Preamps

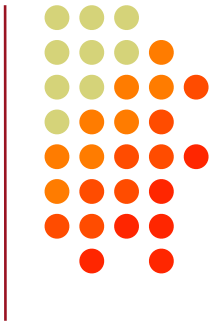


- **50 MHz**
  - Not needed unless your radio is really deaf
    - New radios like Flexradio SDR's and K3 do need a preamp!!!!!
- **144 MHz**
  - Recommended for radios, DEMI xvtrs are FB
- **222 & 432 MHz**
  - STRONGLY recommended
- **902 & Above**
  - ***Mandatory!***

CTU CONTEST UNIVERSITY

ICOM

Equipment - Amplifiers

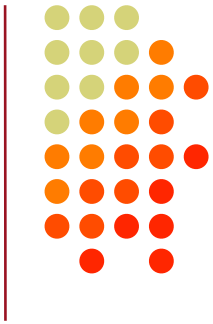


- Before you sink a lot of money into a high power amplifier, learn the real facts about “gain”!
- Only needed if you want to enter the high power category
- There are no “multiband VHF/UHF amplifiers
- Outstanding gain can be achieved by stacking antennas

CTU CONTEST UNIVERSITY

ICOM

Equipment - Radios



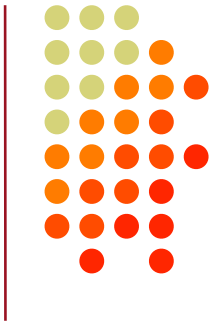
- The VERY BEST radio for VHF contesting is

?

CTU CONTEST UNIVERSITY

ICOM

Equipment - Transverters



- Provide low noise receive front ends
- Provide transmit RF
- Combined with a high end transceiver makes an outstanding system

CTU CONTEST UNIVERSITY

ICOM

Rovers

N5AC Rover

Antenna Restricted at Home

W5ZN Rover

CTU CONTEST UNIVERSITY

ICOM

Rovers

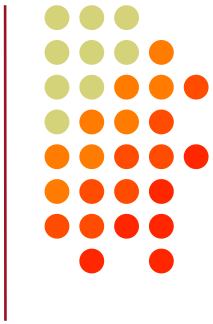
Six compact Rover Stations

Vehicle not included!

CTU CONTEST UNIVERSITY

ICOM

Contest Strategy

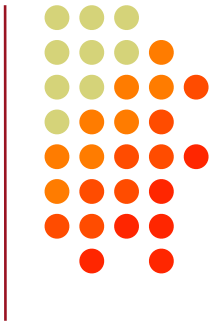


- **Once you decide what you want to do, you must fully understand what will be required to achieve that objective.**
  - How many points do I need?
    - How many Q's? How many grids (multipliers) ?
  - What equipment do I need.
  - When are the prime propagation times to particular areas

CTU CONTEST UNIVERSITY

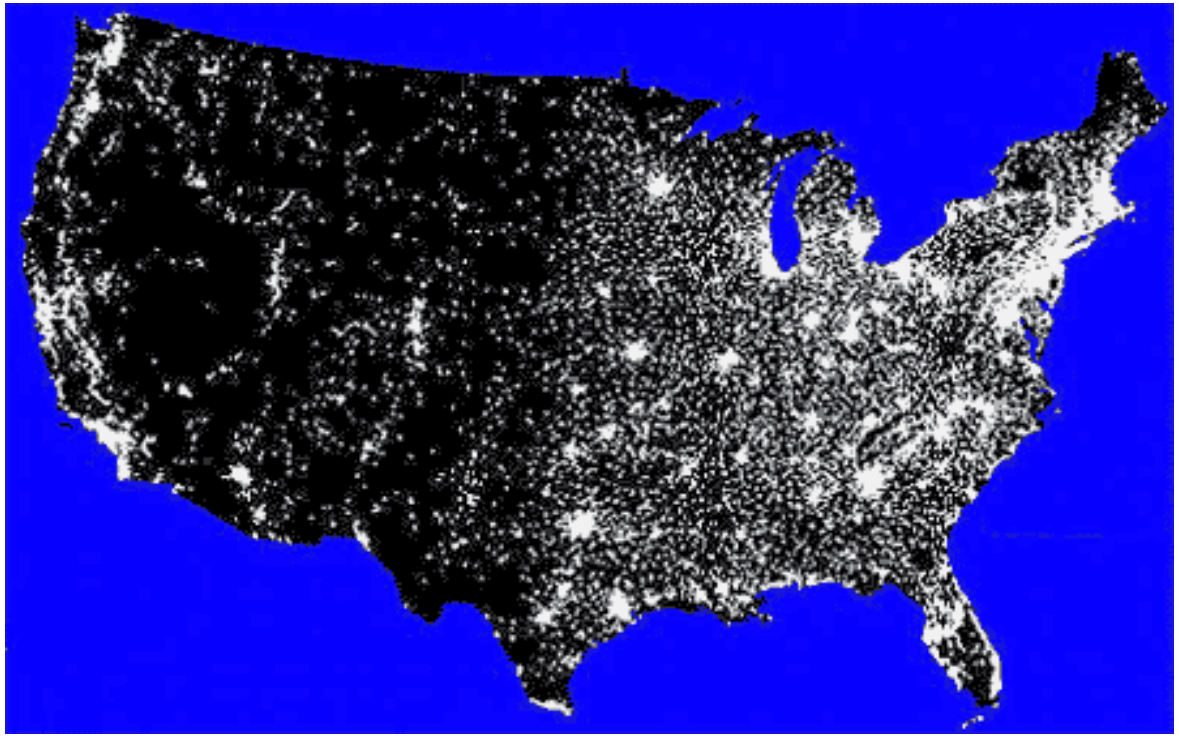
ICOM

Contest Strategy



- **Determine what others are accomplishing**
  - Evaluate top 10 scores for past 10 years
- **Its not all about making the most QSO's**
  - Maximize grid multipliers
- **Get Rovers out to dead grids**

Contest Strategy
How To Maximize Your Score



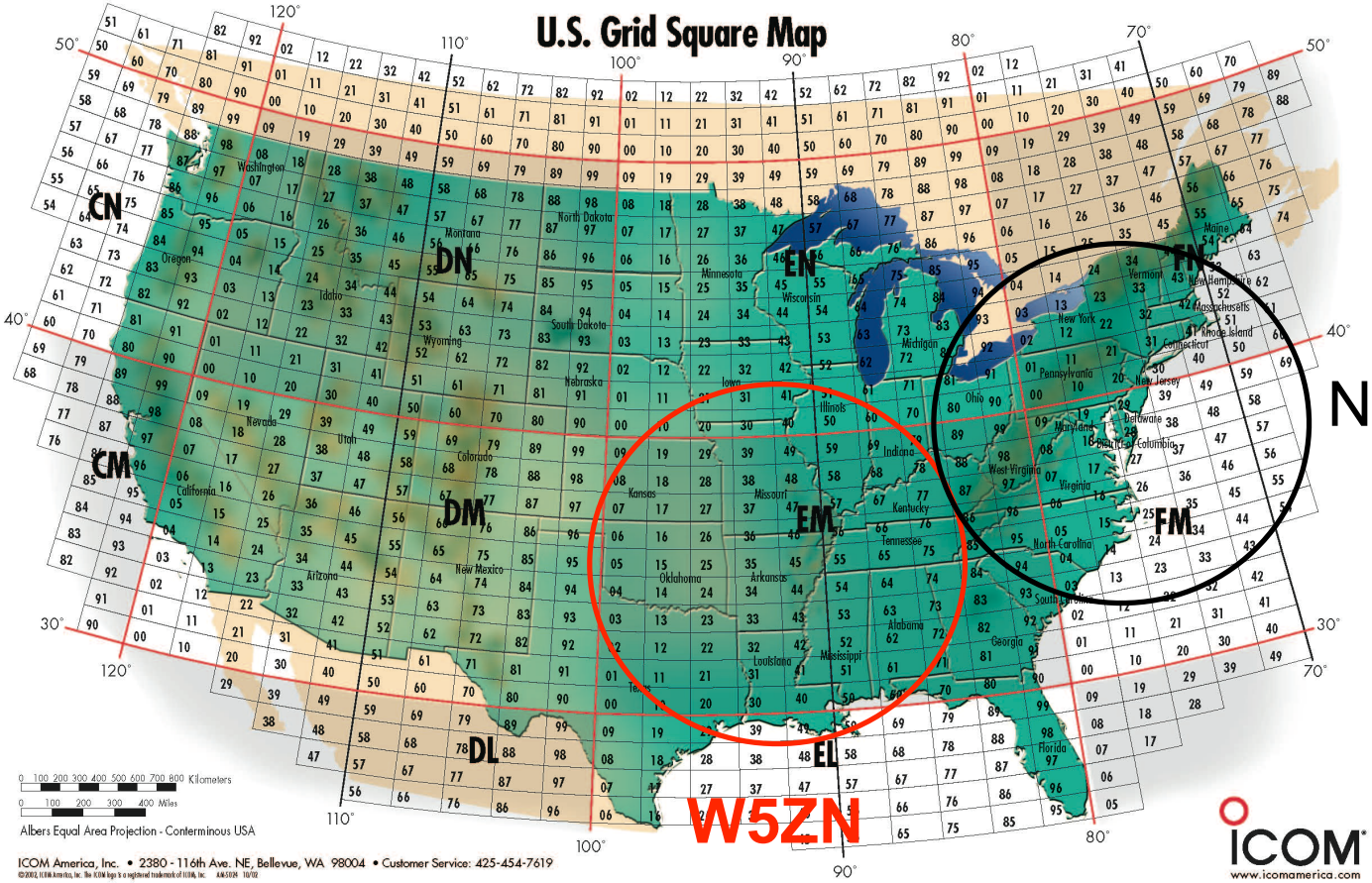
Night time Satellite Photo Reveals Population Density

CTU CONTEST UNIVERSITY

ICOM

Contest Strategy

Grids Within 500 Mile Radius



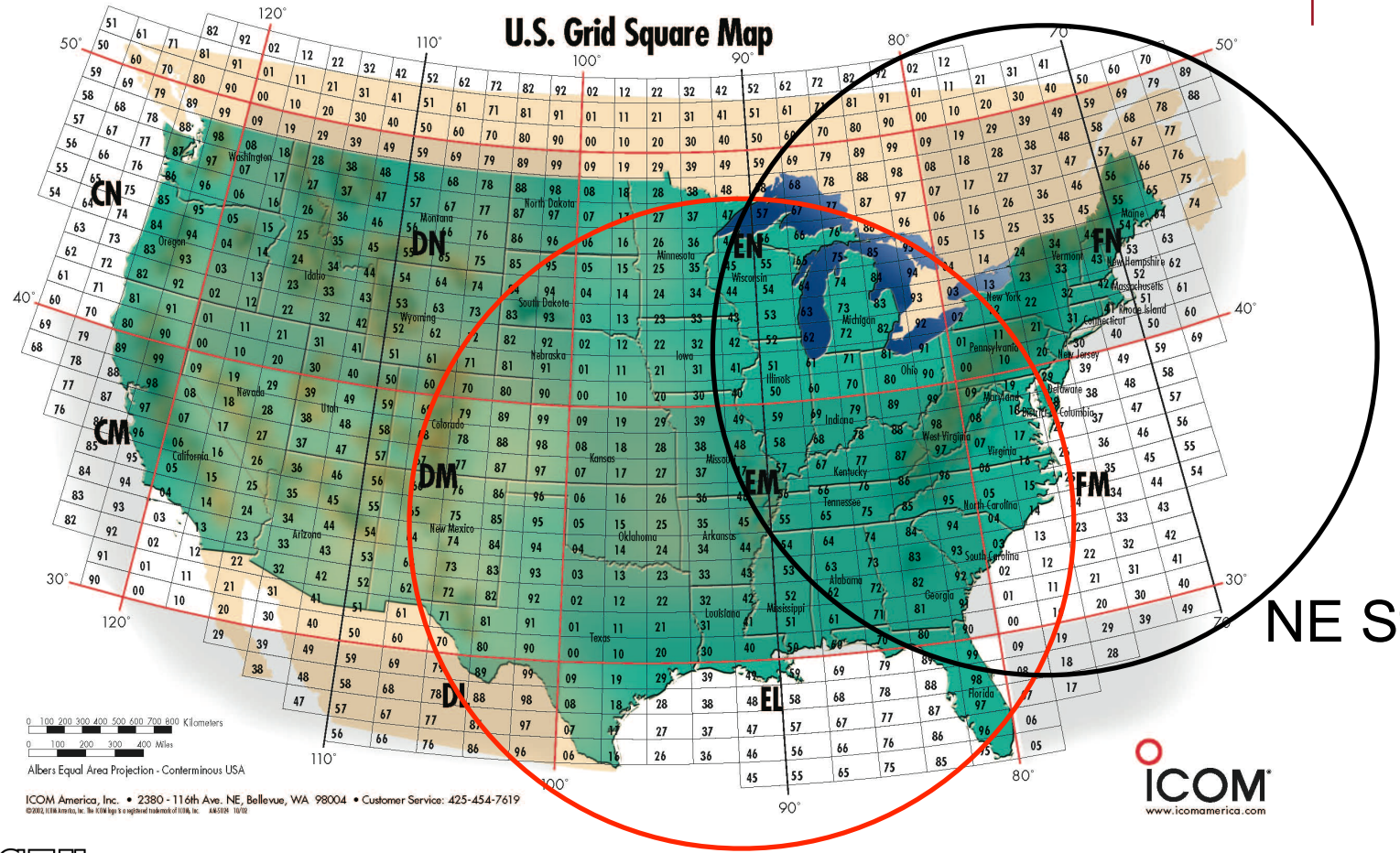
ICOM
www.icomamerica.com

CTU
CONTEST
UNIVERSITY

ICOM

Contest Strategy

Sporadic E 1000 mi Radius

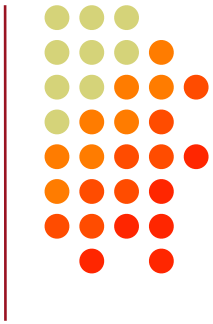


CTU CONTEST UNIVERSITY

ICOM www.icomamerica.com

ICOM

Contest Strategy
How Do I Activate Dead Grids?

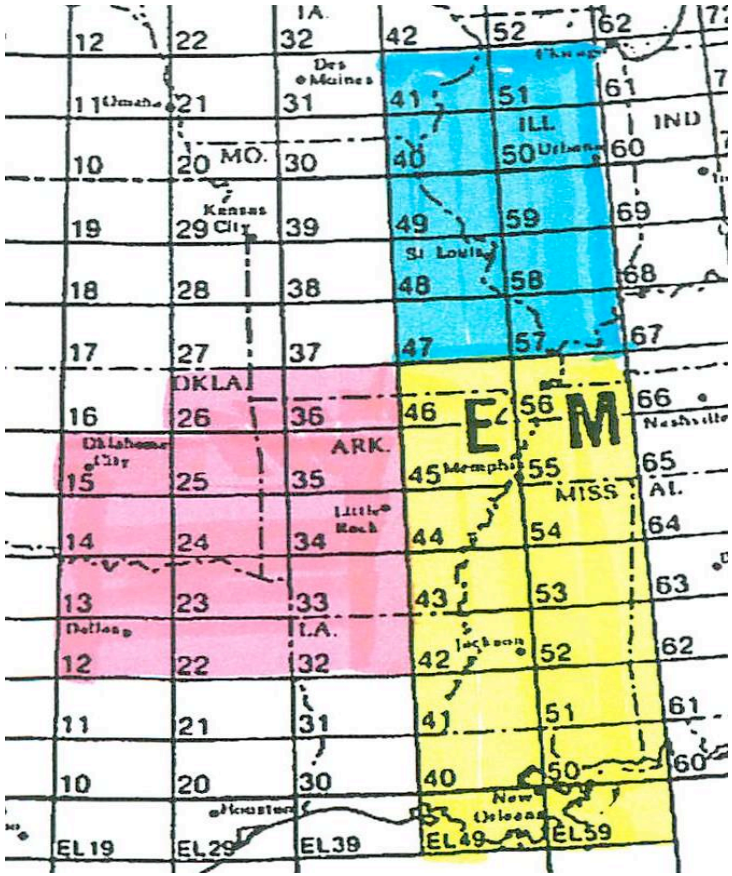


- **Rovers**
  - Assembled Your Own Rover stations
    - 50 MHz thru 10 GHz, one with 24 GHz
  - Recruite & Train Operators
  - Analyzed routes
    - Maximize grids, minimize travel time

CTU CONTEST UNIVERSITY

ICOM

Contest Strategy
Planning Rover Routes



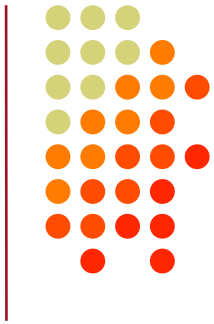
W5ZN Rover Routes

CTU CONTEST UNIVERSITY

ICOM

Contest Strategy

Prime Operating Times

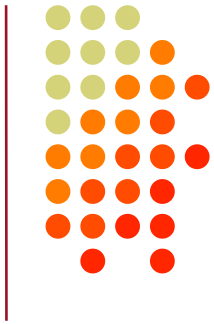


- **6 Meters**
  - Daylight hours, early evening
  - ***PRIORITY band when it is open***
- **144 MHz & Up**
  - Anytime
- **Sunday Morning – DO NOT MISS**
- **Midnight to 5 AM – DEAD!!!**
  - Have your rovers positioned
  - Meteors & EME with JT Modes

CTU CONTEST UNIVERSITY

ICOM

Contest Strategy
Prime Operating Times

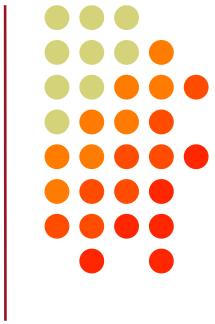


NO DEAD TIME ALLOWED

CTU CONTEST UNIVERSITY

ICOM

Contest Strategy
How Do I Increase Q Totals?

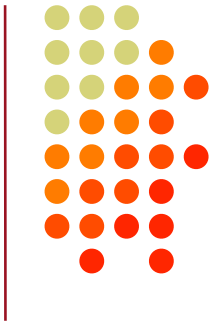


- **2 Meter FM**
  - FM is NOT a four-letter word
  - The Q's count and can add up nicely
  - Excites the local club and introduces them to contesting
  - They get to be a part of the big winning team!
  - Give a presentation at the local club, most new hams have an HT.

CTU CONTEST UNIVERSITY

ICOM

Other Important Points

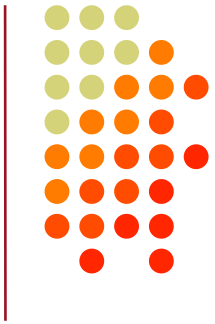


- **The Same Principles for HF Apply to VHF**
  - Tower & Electrical Safety
  - Station Ergonomics
  - Physical Fitness
  - **ETHICS !!!**
    - A system of moral values and motivation based on right and wrong
      - "The rules are black and white, we make them gray!"
        K5ZD, CTU Dayton 2009

CTU CONTEST UNIVERSITY

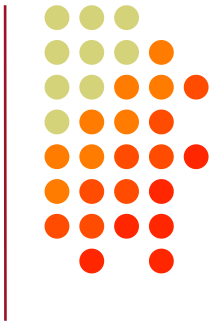
ICOM

Other Important Points



- **Can't Buy Me Love! – Beatles, 1964**
  - You can**not** buy a contest victory
    - Money can buy nice equipment & antennas but it will ***not*** teach you how to operate & apply them effectively
  - You **must** study & learn propagation
  - You **must** study & learn antennas
  - You **must** study & learn equipment
  - You **must** study & learn when & where to be at the right time

Where Can I Learn More?



- VHF Conferences & Microwave Update
  - Central States VHF Society (CSVHFS)
  - Northeast Weak Signal Society (NEWS)
  - Southeast VHF Society (SEVHFS)
  - Western States Weak Signal Society (WSWSS)
  - Microwave Update Conference
- Not “traditional” hamfests
- Publish proceedings (compilation of technical papers)