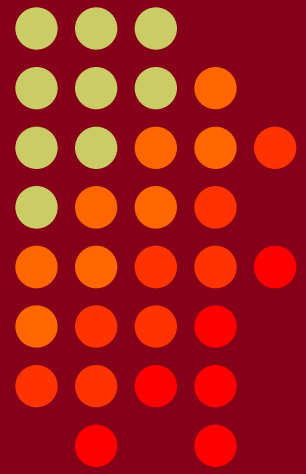
# How to Improve Your Transmitting Antennas for Low Solar Activity

- Vertically polarized 160 meter antennas
- Horizontally polarized 80-10 meter antennas
- Single Yagi and single tower stations
- Stacked Yagis
- Quantitative performance evaluation



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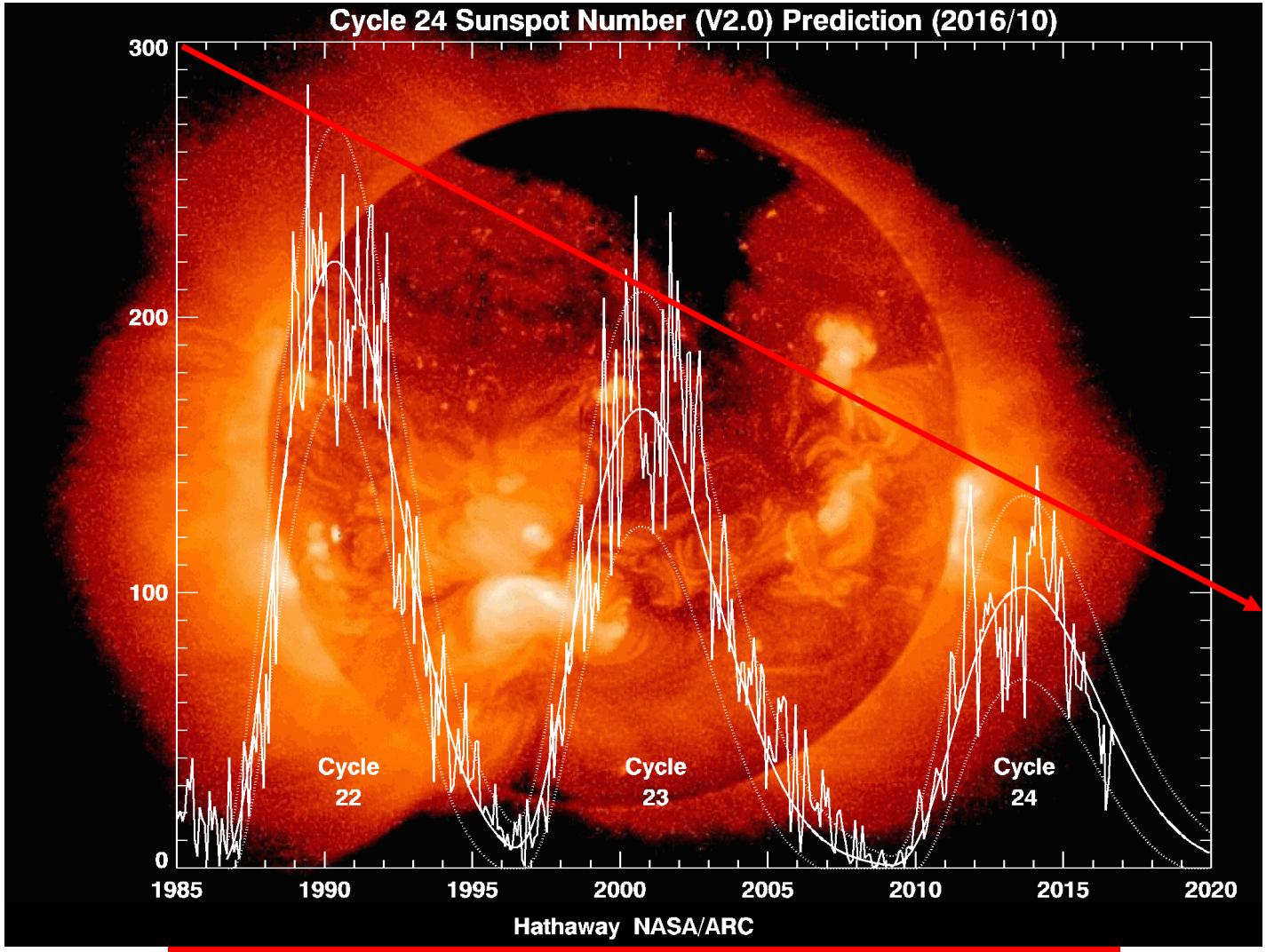
Dayton 2017

# Five Years of Very Low Solar Activity

## Solar activity should start to increase by 2020




Cycle 25

Solar activity remains low until 2022

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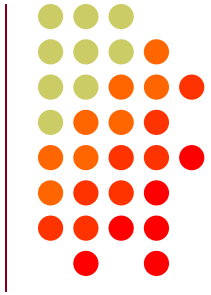
# Transmitting Antenna Elevation Angles Needed for Low Solar Activity



- 10 meters – primarily open to the south
  - almost all DX propagation is at elevation angles below 10 degrees
  - many marginal DX paths require elevation angles well below 5 degrees
- 15 meters – much shorter openings to Europe
  - almost all DX propagation is at elevation angles below 10 degrees
  - many marginal DX paths require elevation angles well below 5 degrees
- 20 meters – the most crowded daytime DX band
  - almost all DX propagation is at elevation angles below 15 degrees
  - most marginal DX paths require elevation angles well below 10 degrees
- 40 meters – the most crowded afternoon and night DX band
  - almost a 24 hour DX band especially during CQWW CW in late November
  - wide variety of elevation angles are needed from 5 to 25 degrees
- 80 meters – a very important DX band for the next five years
  - very efficient antennas for angles below 10 degrees to 30+ degrees
- 160 meters – an excellent DX band for the next five years
  - vertical antennas are the only efficient 160M DX transmitting antennas

# 6 dB of “Free” Ground Gain

- Vertically polarized antennas can achieve 6 dB ground gain only over highly conductive soil such as a salt marsh
- A horizontally polarized dipole, Yagi or quad easily provides 6 dB of valuable ground gain
  - but only if you install it an appropriate height
- Higher antennas are needed during low solar activity
- Stacked HF Yagis achieve higher gain mainly by suppressing undesired high angle radiation and redistributing the power into the main low angle beam
  - stacked Yagis must be installed at appropriate heights to achieve the expected results

# Vertical Polarization for 160 Meters

## *almost always* provides better DX performance than any horizontally polarized antenna

- Vertical, inverted-L, T, and umbrella transmitting antennas *almost always* outperform horizontally polarized antennas at distances beyond 1500 miles

- Nearby tall towers and antennas can significantly degrade the performance of vertical antennas
  - antenna pattern degradation
  - losses

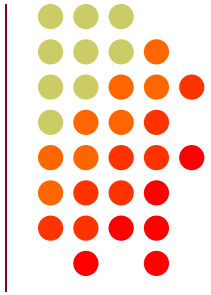
- Efficient radial systems are essential to achieving the full performance potential of vertical transmitting antennas

# Horizontal Polarization for 80 Meters

## easily provides 6 dB of "free" ground gain

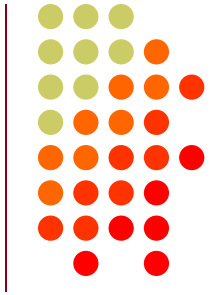
- Horizontal dipole or inverted-V dipole 50-70 feet high
  - superb Sweepstakes and Field Day antenna
  - a good DX antenna for distances up to about 5000 miles
- Horizontal dipole or inverted-V dipole at 70 feet or higher
  - outperforms a single 65 foot vertical installed over all but the most conductive soils such as a salt marsh
- Use a vertically polarized antenna if you cannot install a dipole or inverted-V dipole at least 70 feet high
  - 65 foot vertical, inverted-L, T or umbrella with at least 30-60 radials
  - or a corner fed delta loop or inverted-U
- **Four-square vertical array**
  - with at least sixty 70 foot shallow buried radials per vertical
  - very competitive with high horizontally polarized arrays

# High Performance Transmitting Antennas for 160 Meter DX



- 125 foot vertical: the gold standard 160 meter antenna
  - well spaced from all nearby tall towers and antennas
    - at least 140 feet from towers over 80 feet tall supporting large HF Yagis
    - optimum performance with spacing much greater than 140 feet
  - Install at least 30-60 shallow buried 125 foot radials
    - or at least two (preferably four or more) elevated 125 foot radials
      - but only if 30-60 shallow buried 125 foot radials are not possible
    - or a K2AV folded counterpoise (a counterpoise for small lots)
- Inverted-L, T and umbrella antennas are good alternatives
  - 50 feet or higher (as short as 35 feet with reduced performance)
  - supported by a tower, mast or trees
- Vertically polarized corner fed delta loop

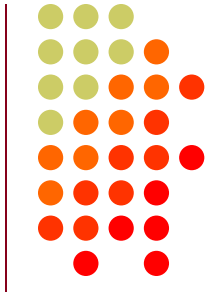
# High Performance Transmitting Antennas for 80 Meter DX



- Horizontal dipole at least 70-100 feet high
  - higher is better
- 65 foot vertical
  - install at least 30-60 shallow buried 65 foot radials
    - or at least two (but preferably four or more) elevated 65 foot radials
      - only if buried radials are impossible
  - at least 70 feet from towers over 40 feet tall supporting a Yagi antenna
    - optimum performance with much more than 70 foot spacing
- Inverted-L, T and umbrella verticals are good alternatives
  - as little as 25 feet tall supported by a tower or trees
  - install at least 30-60 shallow buried 65 foot radials
    - or elevated radials
    - or a reduced size counterpoise
- Or a vertically polarized corner fed delta loop

# 4-Square Vertical Array

**an excellent high performance alternative to a very high 80 meter horizontal antenna**

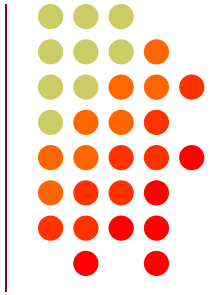


- A four square vertical array is very competitive with high horizontally polarized Yagis and quads
  - its also an excellent receiving antenna
- install at least 70 feet from all other towers
  - much more than 70 feet will significantly improve its performance
- at least 30-60 shallow buried 70 foot radials under each vertical

# Comtek 4-Square Controller


www.dxengineering.com/search/brand/comtek

# High Performance 40M Antennas

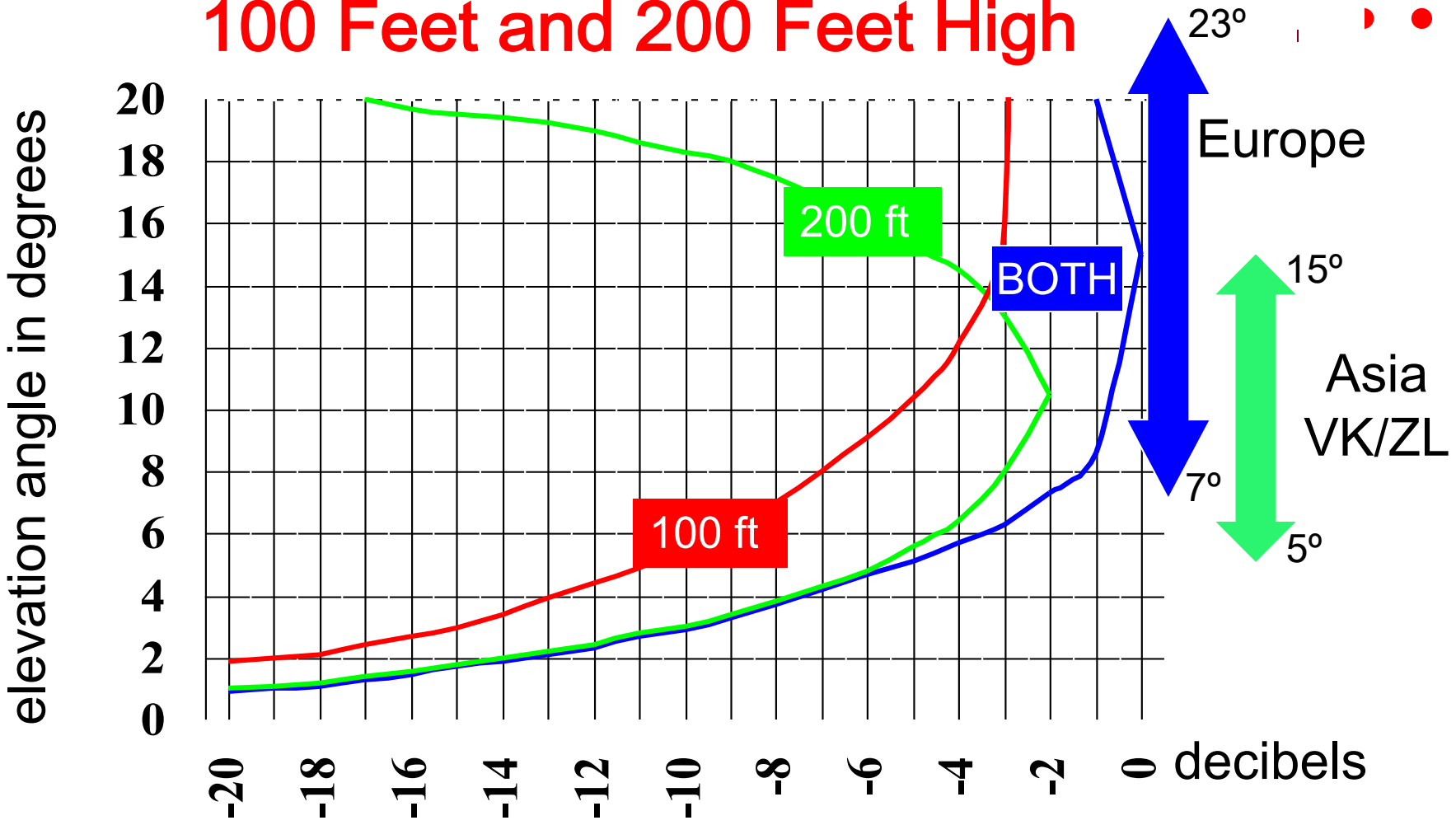


- High horizontal dipole at least 70 feet high
  - 13-45 degree elevation beam pattern at -3 dB points
  - otherwise use a four-square vertical array with 30-60 radials
- Higher gain: 2 element Yagi at 70-100 feet high
  - 10-30 degree elevation beam pattern at -3 dB points
  - significant improvement over a simple horizontal dipole for DX
  - a Cushcraft XM-240 at 100 feet high is very cost effective
- Highest gain: full size 3 element Yagi at 140+ feet high
  - 7-20 degree elevation beam pattern at -3 dB points
  - but don't underestimate the high cost and complexity of the effort !



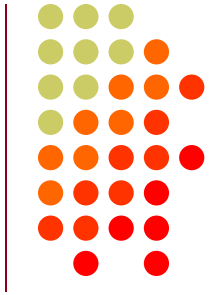
Elevation angles from <5-25º are needed

# Stacked 3 Element 40 Meter Yagis
## 48 Foot Booms
## 100 Feet and 200 Feet High




Elevation angles from <5-25º are needed

# 4-Square Vertical Array for 40 Meters



- A 4-square vertical array is good alternative to a Yagi if you cannot install it at least 70 feet high
  - install a 4-square at least 40 feet from all towers
    - more spacing will significantly improve its performance
  - at least 30 to 60 slightly buried 35 foot radials under each vertical
- A 4-square is an excellent receiving antenna

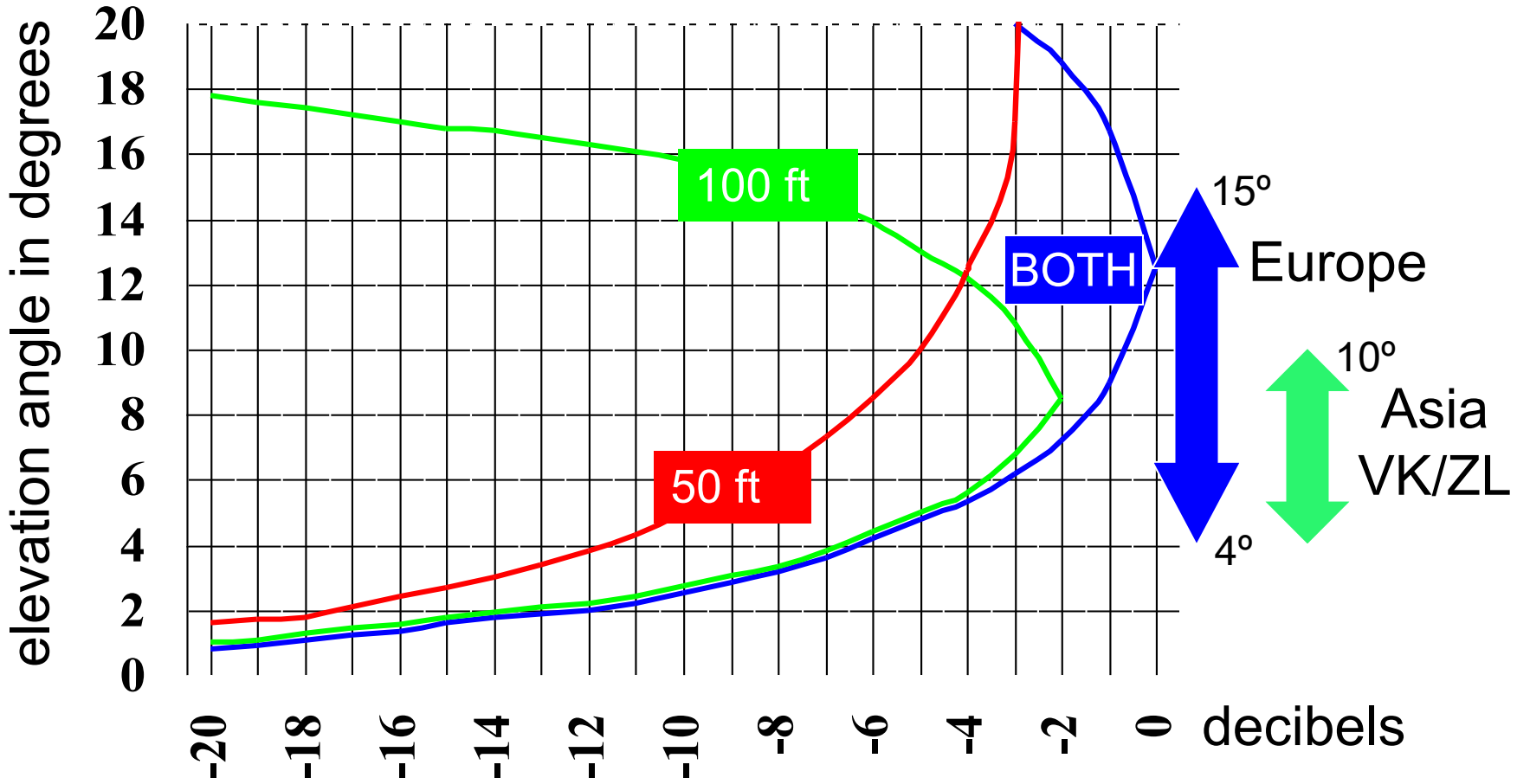
# High Performance 20M Antennas

- A horizontal Yagi or quad is always the best choice
  - if you can install your antenna at 35 feet high or higher
  - 13-45 degree elevation beam pattern at -3 dB points
- Moderate gain: small tri-band Yagi, hex-beam or quad
  - a small Yagi at 50 to 70 feet high will produce good DX results
  - 10-30 degree elevation beam pattern at -3 dB points
- High gain: full size tri-band Yagi, small monoband Yagi or quad
  - 70 to 100 feet high
  - 7-20 degree elevation beam pattern at -3 dB points
- Highest gain: two stacked monoband Yagis
  - 100-140 foot tower (170 to 200 foot tower for three stacked Yagis)
  - 3-15 degree elevation beam pattern at -3 dB points
  - stack switching ( a “stackmatch”) provides high payoff at low cost



Elevation angles from <5-15º are needed

# Stacked 5 Element 20 Meter Yagis
## 48 Foot Booms
## 50 and 100 Feet High




Elevation angles from <5-15º are needed

# The Array Solutions Stack Match




www.arraysolutions.com/Products/stackmatch.htm

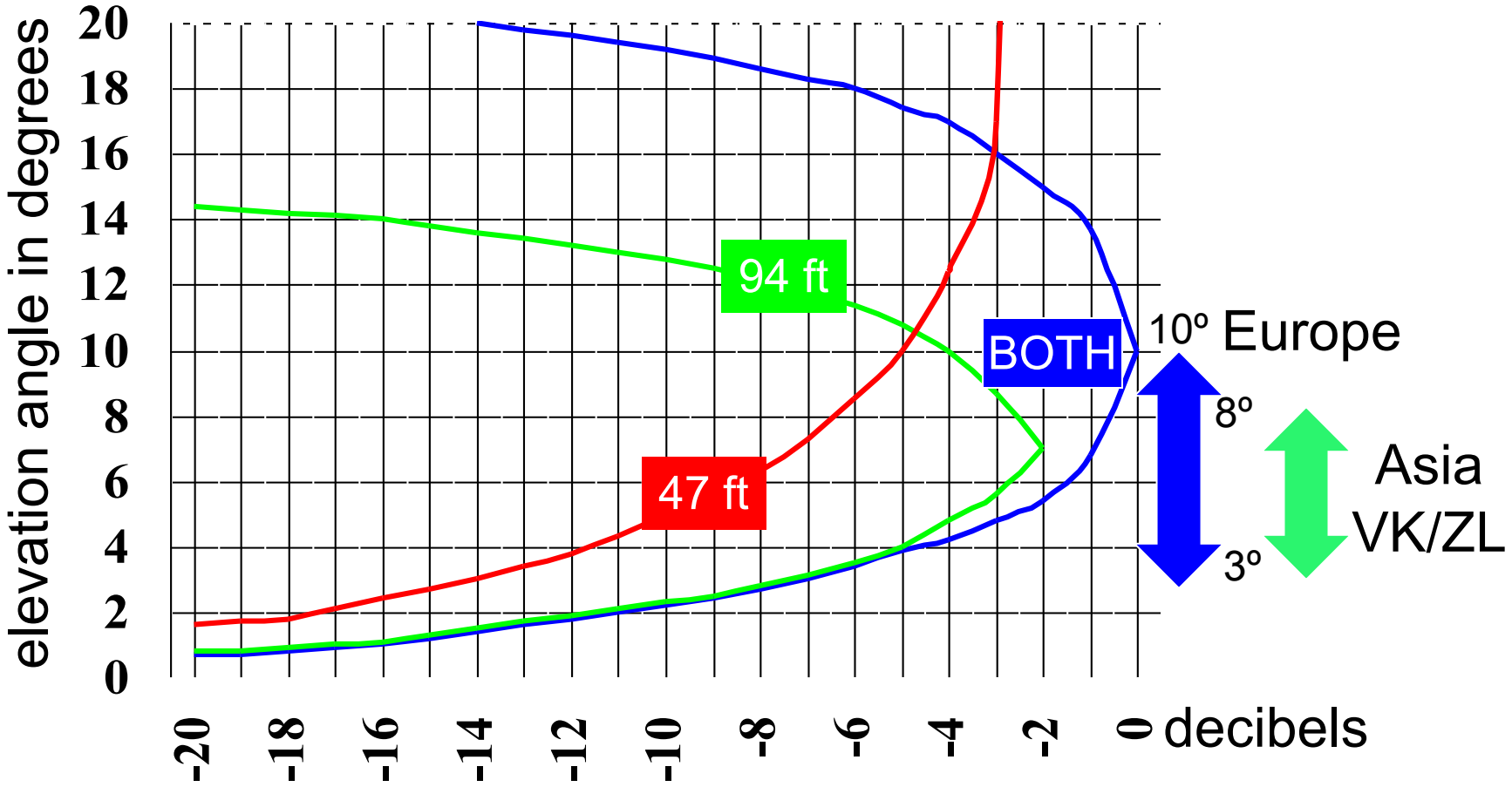
# High Performance 15M Antennas

- A horizontal Yagi or quad is always the best choice
  - if you can install your antenna at 25 feet high or higher
  - 13-45 degree elevation beam pattern at -3 dB points
- Moderate gain: small tri-bander Yagi, hex-beam or quad
  - a small Yagi at 50 feet high will produce good DX results
  - 7-20 degree elevation beam pattern at -3 dB points
- High gain: full size tri-band Yagi, small monoband Yagi or quad
  - 70 to 100 feet high
  - 5-15 degree elevation beam pattern at -3 dB points
- Highest gain:  two stacked monoband Yagis
  - 70-90 foot tower (120 to 140 foot tower for three stacked Yagis)
  - 4-15 degree elevation beam pattern at -3 dB points
  - stack switching ( a “stackmatch”) provides high payoff at low cost



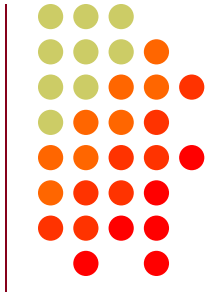
Elevation angles from <5-10º are needed

# Stacked 6 Element 15 Meter Yagis
## 48 Foot Booms
## 47 and 94 Feet High




Elevation angles from <5-10º are needed

# High Performance 10M Antennas

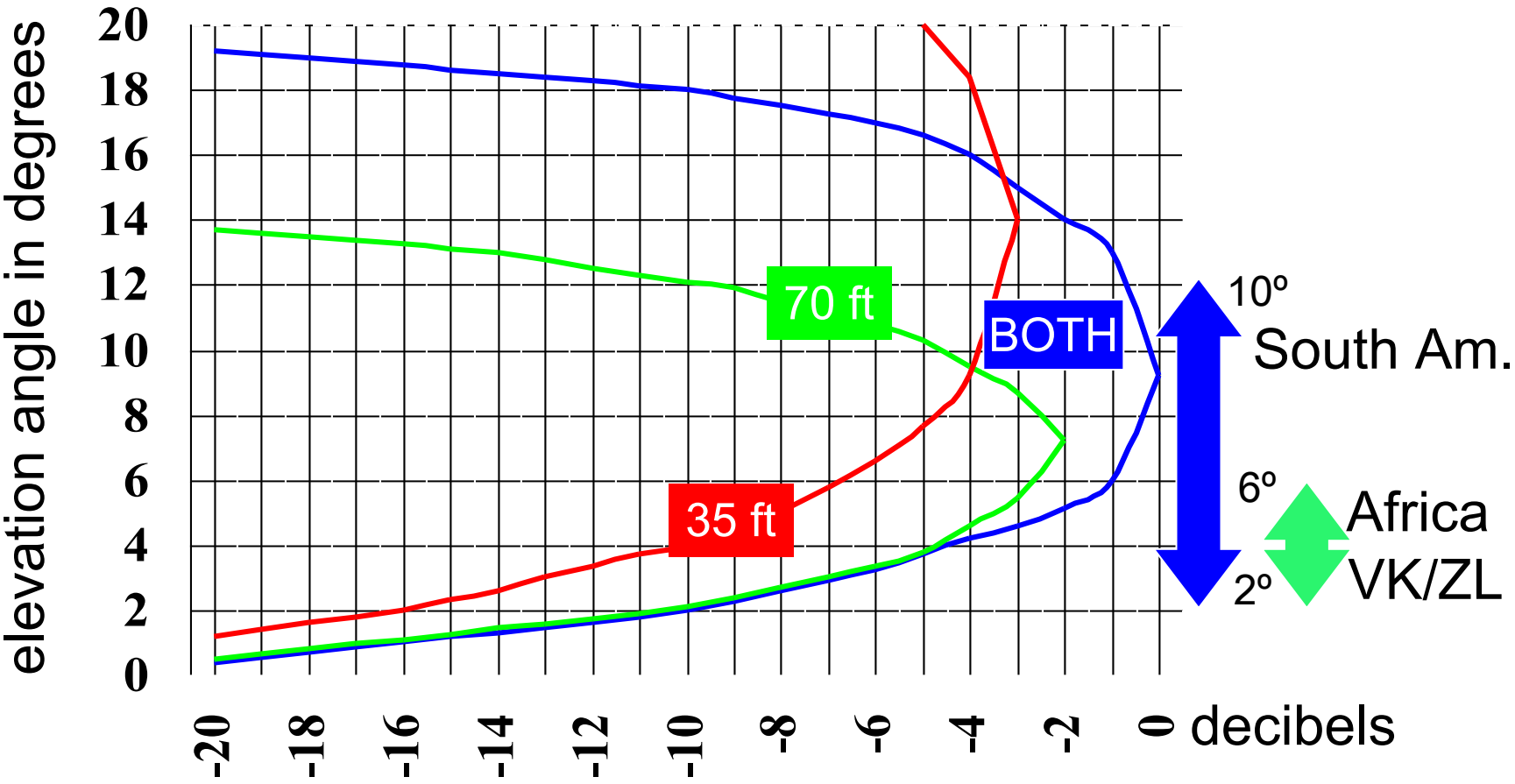


- A horizontal Yagi or quad is always the best choice
  - if you can install your antenna at 20 feet high or higher
  - 13-45 degree elevation beam pattern at -3 dB points
- Moderate gain: small tri-bander Yagi, hex-beam or quad
  - a small Yagi at 40 feet high will produce good DX results
  - 7-20 degree elevation beam pattern at -3 dB points
- High gain: full size tri-band Yagi, small monoband Yagi or quad
  - 50 to 70 feet high
  - 5-15 degree elevation beam pattern at -3 dB points
- Highest gain:  two stacked monoband Yagis
  - 60-70 foot tower (90 to 100 foot tower for three stacked Yagis)
  - 4-15 degree elevation beam pattern at -3 dB points
  - stack switching ( a “stackmatch”) provides high payoff at low cost



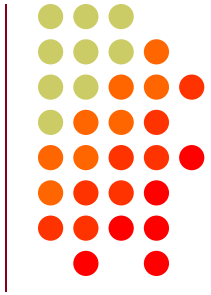
Elevation angles from <5-10º are needed

# Stacked 6 Element 10 Meter Yagis
## 36 Foot Booms
## 35 and 70 Feet High




Elevation angles from <5-10º are needed

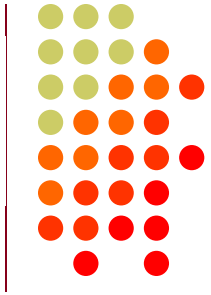
# Competitive One Tower Antenna Systems



- 50-70 foot tower and a small rotator (e.g., HyGain Ham-IV)
  - small tri-band Yagi, Hex-beam or quad
  - 40 and 80 meter dipoles and a 160 meter inverted-L
- 70-90 foot tower and a medium rotator (e.g. HyGain T2X)
  - Cushcraft XM-240 two element 40 meter Yagi
  - large tri-band Yagi such as the DX Engineering Skyhawk
  - 80 meter dipole and a 160 meter inverted-L
- 100-140+ foot tower and a large rotator (e.g., M2 Orion)
  - Cushcraft XM-240 two element 40 meter Yagi
  - monoband Yagis such as the Hy-Gain LJ series on ring rotators
  - 80 meter dipole and a 160 meter inverted-L

# Quantitative Performance Evaluation

Use the WSPR network to compare your antenna performance



| Date | Call | Frequency | SNR | by | mi |
|---|---|---|---|---|---|
| 2017-03-30 02:22 | W3LPL | 3.594127 | -18 | LX1DQ | 3944 |
| 2017-03-30 02:22 | W3LPL | 3.594134 | -26 | PI9ESA | 3808 |
| 2017-03-30 02:22 | W3LPL | 3.594131 | -18 | EA1FAQ | 3685 |
| 2017-03-30 02:22 | W3LPL | 3.594127 | -19 | DK6UG | 4030 |
| 2017-03-30 02:22 | W3LPL | 3.594128 | -28 | ON7DS | 3833 |
| 2017-03-30 02:22 | W3LPL | 3.594133 | -22 | DF2JP | 3915 |
| 2017-03-30 02:22 | W3LPL | 3.594132 | -16 | ON5KQ | 3792 |
| 2017-03-30 02:22 | W3LPL | 3.594145 | -23 | DL/PA0EHG | 3914 |
| 2017-03-30 02:22 | W3LPL | 3.594142 | -27 | DL1GCD | 4046 |
| 2017-03-30 02:22 | W3LPL | 3.594148 | -28 | DL1HI | 4034 |
| 2017-03-30 02:22 | W3LPL | 3.594128 | -24 | DK8FT | 4193 |
| 2017-03-30 02:22 | W3LPL | 3.594129 | -25 | DL9GCW | 4138 |
| 2017-03-30 02:22 | W3LPL | 3.594129 | -24 | G0KTN | 3551 |
| 2017-03-30 02:22 | W3LPL | 3.594128 | -13 | GX3WSC | 3645 |
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| 2017-03-30 02:22 | W3LPL | 3.594121 | -25 | HB9UQF | 4089 |
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| 2017-03-30 02:22 | W3LPL | 3.594129 | -22 | G0BLB | 3544 |
| 2017-03-30 02:22 | W3LPL | 3.594129 | -19 | F1VMV | 4045 |